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MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. II.

By R. LYDEKKER, B.A.; F.G.S.; F.Z.S.

- Part I., Dec., 1881 - - SIWALIK RHINOCEROTIDÆ.
" II., " " - - SUPPLEMENT TO PROBOSCIDA.
" III., Jan., 1882 - - SIWALIK AND NARBADA EQUIDÆ.
" IV., Dec., " - - SIWALIK CAMELOPARDALIDÆ.
" V., Feb., 1883 - - SIWALIK SELENODONT SUINA.
" VI., Jan., 1884 - - SIWALIK AND NARBADA CARNIVORA.

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PREFACE.

THE present volume contains descriptions of the following groups of Indian fossil mammals; *viz.*, the rhinoceroses and horses; certain Proboscidea; the giraffe-like and sivatheroid animals; a group of Pig-like Artiodactyle Ungulates; and the Carnivora. It will thus be seen that the order of the parts follows no systematic arrangement; the different groups having been taken up as materials accumulated. It will also be noticed that in the majority of cases the remains described are either teeth, jaws, or skulls; this circumstance being due to the following causes. In the first place, since the remains of Siwalik animals are nearly always found disassociated, with the long-bones generally broken, while in many of the genera there are numerous species often closely agreeing in respect of size, there is usually no kind of clue towards assigning individual bones to their respective species, even when they are generically determinable; so that under these circumstances in many instances nothing would be gained by describing them. In the second place, the quantity of remains of Siwalik vertebrates in the Indian Museum is so great that to attempt a description of anything like the whole collection would simply swamp the present arrangements for publication. The plan hitherto followed has been to describe the more important and characteristic remains of each species, in the manner best adapted in the writer's opinion to display its general affinities. It is only by adopting some such restrictions that it will be possible (if the present arrangement be continued) to give a general survey of the whole Siwalik Fauna.

It is hoped that palæontologists will find the execution of the plates of the last two parts more satisfactory than some of those of the earlier parts, many of which were drawn and lithographed by native artists.

In regard to the same parts, I have to return my thanks to Dr. Henry Woodward, LL.D., F.R.S., Keeper of the Geological Department of the British Museum, for access to, and the liberty to figure the specimens under his charge. To Prof. Flower, LL.D., F.R.S., Curator of the Museum of the Royal College of

Surgeons, for permission to figure specimens in that collection, and for free access to the whole of the same. To Dr. Günther, M.A., F.R.S., Keeper of the Zoological Department of the British Museum, for free access to the osteological collection of that institution. To Mr. William Davies, F.G.S., of the British Museum, for much valuable information regarding the Siwalik Carnivora in the National Collection. To Prof. V. Ball, M.A., F.R.S., Director, and Mr. A. G. More, Curator of the Science and Art Museum, Dublin, for the opportunity of examining the Siwalik Carnivora in that collection. To Dr. J. E. Taylor, Ph.D., Curator of the Ipswich Museum, for permission to figure an important specimen in that collection. To Prof. George Busk, M.D., F.R.S., for the opportunity of figuring a specimen lately in his possession, and now presented to the British Museum. To the Publishing Committee of the Zoological Society, to the Council of the Geological Society, and to the Chief Librarian of the British Museum, for permission to reproduce woodcuts from their publications. My thanks are also due to numerous palæontologists for copies of their memoirs on fossil mammals; and to the Editorial Staff of the "Geological Record," for the opportunity of seeing the manuscript of several of the forthcoming volumes.

In answer to several inquiries why the English, in place of the decimal, system of mensuration has been adopted, I may state that this course has been followed in order to bring this work into harmony with the "Fauna Antiqua Sivalensis."

I cannot conclude without expressing my sense of the high value for palæontological purposes of the two following memoirs; *viz.*, one by Prof. Busk, "On the Cranial and Dental Characters of the existing species of *Hyæna*"; and the other by Prof. Huxley "On the Cranial and Dental Characters of the *Canidæ*." It is to be hoped that other families may be treated in the same manner.

It should be observed that in the earlier parts the names of the founders of species are universally enclosed in brackets: in the latter parts they are only so enclosed when the generic name has been changed.

RICHARD LYDEKKER.

THE LODGE,

HARPENDEN,

HERTFORDSHIRE,

January, 1884.

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ADDENDA AND CORRIGENDA.¹

Page 5-7. The range in time of the rhinoceroses of the later European tertiaries, according to Prof.

Boyd Dawkins,² should be as follows, *viz.* :—

R. etruscus. Up. pliocene to lower pleistocene.

R. leptorhinus, Ow. Mid. and upper pleistocene.

R. megarkinus, Christ. Low. pliocene to mid. pleistocene.

R. tichorhinus. Mid. and upper pleistocene.

„ 21, line 17 from top for *occidentale* read *occidentale*.

„ 60, „ 9 „ „ „ *Gérard* „ *Gérard*.

„ 76. In the table of measurements the premolars numbered 1st, 2nd, 3rd, should be 2nd, 3rd, 4th.

„ 100, line 18 from top for *Orasius* read *Orasius*.

„ 126, „ 16 „ bottom „ *proximals* „ *proximal*.

„ 134, „ 13 „ „ „ *bar* „ *base*.

„ 140, „ 2 „ top „ *Mesacerops* „ *Megacerops*.

„ 146. According to Prof. Gaudry, it is *Palaeocherus*, rather than *Hyotherium*, which is nearest to *Dicotyles*: it is, however, probable that the two fossil genera, together with *Charomorus*, should be united. *Amphicherus* is a synonym of *Hyotherium*.

„ 149, top line after *Up. eocene* add *and low. miocene*.

„ 164, line 12 from top for *Gándri* read *Gandoi*.

„ 171, „ 15 „ bottom „ *Láki* „ *Laki*.

„ 189, „ „ „ „ „ *H.* „ *A.*

„ 211, „ 11 „ top „ *caudivolutus* „ *caudivolutus*.

VOLUME I.

„ 283-284 (and elsewhere) the range in time of the three following species of proboscidi-ans should according to Prof. Boyd Dawkins,³ be as follows, *viz.* :—

Mastodon arvernensis. Pliocene.

Elephas meridionalis. Up. pliocene and low. pleistocene.

„ *antiquus.* Pleistocene.⁴

„ 286, line 18 from top for *India* read *Asia*.

In description of plate XLVI., fig. 4, for *true molar* read *milk-molar*.

¹ A few self-apparent misprints (especially in pt. IV., of which the writer did not see the final revise) have been left uncorrected.

² 'Quart. Journ. Geol. Soc.' vol. XXXVI., p. 379, *et. seq.* This memoir had not reached the writer when pt. I. was sent to press. It should be observed that the lower pliocene of Prof. Dawkins does not include the Pikermi beds; which, if classed in that period, may be termed 'Lowest pliocene' (*vide infra* 'Introductory Remarks').

³ *Op. cit.* It may be observed in self-justification that the geological ages of the two species of elephant given in the first volume were taken from Falconer's table ('Pal. Mem.' vol. II., pp. 14-15); the present writer not being then aware of the incorrectness of many of the statements contained therein.

⁴ The pleistocene age of this species invalidates the connection between the geological age and the ridge-formula of the species of *Elephas* noticed in vol. I., p. 288: and also the inference as to *E. antiquus* being older than *E. naumadicus* mentioned in note 2, p. 281.

INTRODUCTORY OBSERVATIONS.

American rhinoceroses.—Since the first part of this volume was written a memoir by Prof. Cope¹ has come under the writer's notice, in which the conclusion is arrived at that none of the American hornless rhinoceroses should be referred to the European genus *Aceratherium*.²: they are now classed as follows,³ viz.:—

Genus I.: PERACEBAS, Cope.

I. $\frac{0}{0}$, C. $\frac{0}{0}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$. Digits?

Peraceras superciliosus, Cope.

„ *malacorhinus*, Cope.=*Aphelops malacorhinus*, Cope.

Genus II.: APHELOPS, Cope.

I. $\frac{1}{1}$, C. $\frac{0}{0}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$. Digits $\frac{3-3}{3-3}$

Aphelops meridianus (Leidy).

„ *megalodus*, Cope.

„ *fossiger*, Cope.

Genus III.: CÆNOPUS, Cope.

I. $\frac{2}{2}$, C. $\frac{0}{0}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$. Digits $\frac{3-3}{3-3}$

Cænopus mitis, Cope.=*Aceratherium mite*, Cope.

The European genus *Aceratherium* has the dental formula of *Cænopus* or *Aphelops*, but the digits (in the type species) are $\frac{4-4}{3-3}$.

The present writer being strongly opposed to the great multiplication of genera, as tending to obliterate the affinities of animals, would prefer to unite the whole of these three new genera with *Aceratherium*; giving them at the most sub-generic value. The differences in their dentition are not greater than those found in the existing rhinoceroses, which the writer likewise unites under one genus; the terms *Atelodus*, *Ceratorhinus*, etc., being used, if at all, as of subgeneric value.⁴ The

¹ "Amer. Nat.," pp. 540-610.

² It appears to be the custom now to spell this name *Aceratherium*, in place of *Acerotherium*.

³ The outer so-called lower incisor is probably a canine.

⁴ Among both the tetralophodont and trilophodont mastodons there are some forms with a produced mandibular symphysis furnished with incisors, while in others the symphysis is short and edentulous. Both of these forms (belonging, be it remembered, to distinct subgeneric groups) would be quite as well entitled to generic distinction, as the various forms of American aceratheres. If the writer were rewriting the first volume of this work, he would drop the names *Stegodon*, *Loxodon*, and *Euelphas*, and merely retain the generic name *Elephas*. He would also pursue much the same course with the *Bovidae*; using the term *Bos* in its old Linnean sense.

x. INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

presence of a small fourth anterior digit in (at least some of) the European *Aceratheria* need not, in the writer's opinion, be reckoned as a character worthy of generic distinction. In the Indian *A. perimense* the feet are unknown, and it is, therefore, impossible to say whether it may not have belonged to one of the American so-called genera.¹

The statement on page 9, note 2, that the post-tympanic and post-glenoid processes of the squamosal of *Aceratherium* appear to be united inferiorly has been found to be incorrect.²

It is stated by Prof. Cope³ that "it is possible that a species of *Aphelops* still exists in some of the Indian islands in the *Rhinoceros inermis*, Less." The present writer, from having seen in Calcutta specimens of the Javan rhinoceros with a very minute horn, is strongly inclined to think that the so-called *R. inermis* is the same as that species. The existence of that form, together with some of the miocene European species, probably indicates that there is really no distinction between *Aceratherium* (in the sense in which it is used here) and *Rhinoceros*; although the retention of the former is convenient.

A separate genus, *Diceratherium*, Marsh, has been formed for the reception of *Aceratherium pacificum* (Leidy), and *Rhinoceros oregonensis*, Marsh, and is said to include⁴ the European *Rhinoceros pleuroceros*, Duvernoy, which in the present volume, after Kaup⁵ and Brandt, has been included with *Aceratherium minutum*; although regarded by others as distinct.⁶

Rhinoceros mercki.—In the list on pages 5-6 *Rhinoceros mercki*, Jäger, is given as a synonym both of *R. clruscus*, Falc., and *R. leptorhinus*, Owen. In the former instance it should have been *R. mercki*, Meyer, which is not the same as Jäger's species.⁷

Additional species of Aceratherium.—To the list of species of *Aceratherium* given on page 4 add—

17. ACERATHERIUM VELAUNUM⁸ (Aymard). Low. miocene, Europe.

Rhinoceros cuvieri (?), Aymard.

Rhinoceros velaunus, Aymard.

Ronzotherium velaunum, Aymard.

Names of the existing Asiatic rhinoceroses.—It is well to mention that, on the grounds of priority, the proper names of the three well-determined species of Asiatic rhinoceroses are undoubtedly *R. sondaicus*, *R. sumatrensis*, and *R. unicornis*: the names *R. javanicus*, *R. sumatrensis*, and *R. indicus* are, however, so convenient, as being exactly equivalent to the terms, Javan, Sumatran, and Indian rhinoceroses, that the first and third have been adopted in place of *R. sondaicus* and *R. unicornis*.

¹ The present writer has been sharply pulled up by Messrs. Scott and Osborn ("Contributions from the E. M. Museum of Geology and Archaeology of Princeton College"—Bul. No. 3, p. 21, Princeton, U.S.A.) for including *Aphelops* with *Aceratherium*. The writer maintains that it was his only course, as the distinctions between the two (apart from the views mentioned above) are not of general applicability.

² Scott and Osborn, *loc. cit.*

³ "Amer. Nat.," Dec., 1879, p. 771b.

⁴ *Ibid.*, p. 771h.

⁵ Kaup, "Beiträge," pt. I. p. 3.

⁶ See Gaudry, "Les Enchaînements du Monde Animal, etc.—Mammifères Tertiaires," pp. 76-6.

⁷ See Forsyth-Major, "Supra alcuni Rhinoceroti fossili in Italia." "Boll. R. Com. geol. Ital.," 1874, p. 94.

⁸ Filhol, "Étude des Mammifères Fossiles du Ronzon." "Ann. Sci. Geol.," vol. XII., art. 3 (reprint), p. 76, 1861.

Hippotherium.—The generic name *Hippotherium*, in place of the older *Hipparion*, has been mainly adopted in conformity with the usage of the "Fauna Antiqua Sivalensis"; of which this work is to be regarded as a continuation.

One of the equine bones from Hündes, in Tibet, noticed on page 68, is a cannon-bone, now in the collection of the Geological Society, and evidently belongs to *Hippotherium*. If the Hündes beds are pleistocene, it is the only known instance of the occurrence of the genus in that period.

Additional species of Equus and Hippotherium.—To the list of species of *Equus* given on pages 71-2 add—

EQUUS TÆNIOPUS,¹ Heuglin. Recent, North Africa.

About the time that the third part of this volume was in the press, a new species of horse, said to be allied to the zebras, was described from the pleistocene of S. America, under the name of *E. lundii*, Boas.² Since the publication of the same part a new species of zebra, inhabiting Shoa and the adjacent districts of that part of Africa, has been described by M. A. Milne-Edwards³ under the name of *E. grevyi*. Assuming this form to be distinct from the allied *E. zebra* of South Africa (not improbably extinct) these additions⁴ make the number of species of *Equus* 25 (of which 10 are, or were recently, living), the African species 7, and the American 12. A new species of *Hippotherium* has been described by Prof. Leidy⁵ from Panama, under the name of *H. montezuma*.

Connection between Hippotherium and Equus.—It may be noticed in reference to the observations on page 79 that there is in the British Museum the metatarsus of a hippothere from Eppelsheim, in which, while the lateral bone is fully developed on one side, on the other it is extremely small, though extending along the whole length of the 'cannon-bone.' This instance looks much like the incipient disappearance of the lateral digits, and indicates a transition from the hippotherian to the equine type. It has been observed by Prof. Flower⁶ that in many of the instances of polydactylism among existing horses, the additional digit (for there is usually but one developed) is due to a splitting of the mesial digit, and cannot therefore be regarded as in any sense a reversion towards *Hippotherium*. In many of these instances, moreover, the supplementary digit is on the inner side; whereas in other perissodactyles the inner digits disappear before the corresponding outer ones. In a polydactyle horse from Bagdad, of which the right *pes* is figured by Mr. J. Wood-Mason,⁷ the supplementary

¹ See Schäter, 'Pro. Zool. Soc.,' 1864, p. 374.

² "Om en fossil Zebra."—'Mem. Acad. Roy. Copenhagen,' 6th ser., Classe des Sciences, vol. I., 1881, p. 307.

³ See 'La Nature,' No. 470 (3rd June, 1882); 'Pro. Zool. Soc.,' 1882, p. 721; *Ibid*, 1883, p. 175.

⁴ From his own observations on their skulls the writer is disinclined to accept the views of some zoologists as to the specific identity of all the wild asses of Asia. See W. T. Blanford, "Eastern Persia, etc.," London, 1876, vol. II., p. 81. *Equus hemippus*, Geoffr., St. Hill, of Syria is by some regarded as distinct from *E. onager*, under which its name should be put on page 72, instead of under *E. hemionus*.

⁵ 'Pro. Ac. Philad.,' 1882, p. 290.

⁶ Lectures on the 'Anatomy of the Horse; Royal College of Surgeons, 1883.

⁷ 'Pro. Asiat. Soc.,' 1871, p. 18, pl. I.

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digit is, however, the outer one (4th), while the 'splint-bone' of the inner digit (2nd) is more developed than usual; and there is no sign of an unsymmetrical development of the main digit (3rd). It seems not improbable that this instance may be one of true reversion; the development of the digits being probably very similar to those of the hippothere mentioned above.

Name of giraffe.—Considerable difficulty has been found in deciding on the generic name to be adopted for the giraffe, since while palæontologists invariably use the name *Camelopardalis* in this sense, by modern zoologists it is restricted to its original Linnian sense of a specific designation for the existing species.¹ The origin of this confusion resulted from the old practice, in cases when a species had to be removed from the genus where it was first placed and assigned to a new one, of taking the specific as the new generic name, and giving a new specific name. Thus *Cervus camelopardalis*, Linn., became *Camelopardalis giraffa*, F. Cuv., instead of *Giraffa camelopardalis* (Linn.). Although there is no question that the latter term is correct, it has been thought best in the text to retain the Cuvierian and palæontological usage of these names.²

Ursus piscator.—On the authority of Prof. Busk,³ *U. piscator*, Puch.,⁴ has been doubtfully classed in the text as a synonym of *U. horribilis*: it is, however, really the same as *U. lasiotis*, Gray⁵: which for palæontological purposes must be included in *U. arctos*.

Hyænarcos from Pikermi.—Since the description of *Hyænarcos* was printed remains of a species of this genus have been recorded by Prof. Dames⁶ from Pikermi; although not specifically determined.⁷

Miocene Canine.—A paper by Prof. Cope⁸ on some miocene canoids has come under the writer's notice since the greater part of the text was in type. The dental formula of *Hyænoeyon* is therein corrected to Pm. $\frac{3}{2}$, M. $\frac{1}{1}$: and a canoid previously referred to *Icticyon* is classed in the new genus *Oligobunis*; the dental formula being Pm. $\frac{4}{4}$, M. $\frac{1}{2}$, and $\overline{\text{m. 1}}$ being furnished with an inner cusp and basin-shaped talon.⁹

Additional Viverra.—*Viverra miocenica*,¹⁰ Pet., a small species from the miocene of Styria, is omitted from the list on pages 267-8.

¹ "Systema Naturæ," ed. 1766, vol. I., p. 92.

² Following the Cuvierian custom (see 'La Règne Animal') the generic term *Camelopardalis* is given with the affix *Linn.*; though it was never employed by him in this sense. After the name *C. giraffa* the affix *F. Cuv.* should be substituted for *Linn.*

³ 'Trans. Zool. Soc. Lon.', vol. X., p. 64.

⁴ In the text, *errorim*, Gray.

⁵ See 'List of Vertebrate Animals in the Gardens of the Zoological Society of London,' 1883, p. 87.

⁶ 'Sitz. Ges. nat. Freunde Berlin,' Oct., 1883, p. 132.

⁷ In comparing $\overline{\text{m. 1}}$ of *H. palæindicus* (*infra*, p. 230) with that of *Dinoeyon* and *Canis*, it might have been observed that the inner cusp of the blade is relatively larger in the former.

⁸ 'Amer. Nat.', vol. XV., p. 497.

⁹ The original reference of this form to *Icticyon* was the cause of Prof. Cope's erroneous definition of that genus mentioned in the note on page 242.

¹⁰ Peters 'Denks. Ac. Wiss.', vol. XXIX., p. 194, pl. III., figs. 8-10.

List of, and remarks on, *Sivalik Carnivora*.—The list of Sivalik Carnivora, as described in the concluding part of this volume, comprehends 33 species; most of which are based on fairly sufficient remains. These may be tabulated as follows, viz.:

Mastelidae	Mellivora sivalensis (F. and C.)	Hyenidae	Hyæna felina, Bosc.
	„ punjabiensis, Lyd.		„ colvini, Lyd.
	Mellivorodon paleindicus, Lyd.		„ macrostoma, Lyd.
	Lutra paleindica, F. and C.		„ sivalensis, Bose.
Ursidae	„ bathygnathus, Lyd.	Felidae	„ sp. non. det.
	„ sivalensis (F. and C.)		Lepthyæna sivalensis, Lyd.
	Ursus theobaldi, Lyd.		Æluroopsis annectans, Lyd.
	Hyænarcos sivalensis, F. and C.		Ælurogale sivalensis, Lyd.
Viverridae	„ punjabiensis, Lyd.	Felidae	Felis cristata, F. and C.
	„ paleindicus, Lyd.		„ (? Cynelurus) brachygnathus, Lyd.
	Amphicyon paleindicus, Lyd.		„ sp. (allied to <i>F. pardus</i>)
	Canis curvipalatus, Bose.		„ sp. (allied to <i>F. lynx</i>)
Viverridae	„ cautleyi, Bose.	Felidae	„ subhimalayana, Bronn.
	„ sp. non. det.		„ (?) sp. non. det.
	Viverra bakeri, Bose.		Macherodus sivalensis, (F. and C.)
	„ durandi, Lyd.		„ paleindicus, Bose.

Hyænodontidae—*Hyænodon indicus*, Lyd.

The most striking feature in this list is the strange mingling of essentially modern forms, with those generally characteristic of the older tertiaries; this being a feature noticeable in all the orders of Sivalik Mammalia, but perhaps in none so strongly as in the present instance. Thus by the side of ratsels, bears, jackals, and civets, some of which are scarcely distinguishable from existing species, there occur essentially primitive forms like *Hyænodon* (or a closely allied genus), *Amphicyon*, *Lepthyæna*, and *Ælurogale*. Although this feature is probably exaggerated by the mingling of genera peculiar to different horizons, yet from the mode of occurrence of many of the forms it must be in the main true; and, in view of the invertebrate evidence afforded by the associated deposits in Sind, admits of but one reasonable explanation:—namely, the survival in the Indian and African areas of old types long after they had disappeared from other parts of the world.¹ This view fully accords with all the facts, and is the only one which brings the condition of the ancient fauna of India into harmony with that of the present day.

Equally noteworthy is the apparently contemporaneous existence of specialized and generalized forms of the same genus; especially well shown in the hyænas. The same group also shows the remarkable fact that the solitary existing Indian hyæna is of a less specialized type than some of the extinct species; probably indicating, as seems to have been the case with the machærodonts, that a high degree of specialization was not invariably advantageous; and thereby conducive to the life of a species.

The Sivalik carnivorous fauna fills up many gaps in the chain of relationship; the points most strongly brought out being the intimate connection between the bears and the dogs; the viverroids and the hyænas; and the cats and the hyænas. There

¹ This explanation was proposed by Mr. W. T. Blanford ("Manual of Geology of India," pt. I., p. LXX.)

are also not wanting certain signs of the connection of the latter with the dogs, which are well known to be intimately related to the viverroids; while *Otocyon* has been brought closer to *Canis*, *Cynælurus* to *Felis*, and *Machærodus* to the more primitive cats. Thus the impartial study of the previously little-known extinct local members of one order of the Mammalia has most decidedly added to the already enormous difficulty of interpreting the mutual relations of extinct and existing beings by any other hypothesis than that of evolution.

Perhaps the most important fact in relation to the distribution of the tertiary Carnivora is that the Siwalik species of *Machærodus* are intermediate between those of Europe and those of S. America. As the latter are the most specialized forms of the genus, and are found in the pleistocene, while the European forms are the most generalized, and usually occur in older strata, it seems probable that the migration of the genus took place in an easterly direction from Europe, through Asia, to America.

Age of lower Siwaliks and European tertiaries.—A word is advisable as to the view taken of the age of the lower Siwaliks on page 143. In 1880, Prof. P. M. Duncan¹ gave a table of the tertiary rocks of Sind in which the lower Manchhars (Siwaliks) were considered to be either of upper miocene, or lower pliocene age; the upper Manchhars (Siwaliks) being referred to the pliocene. In a later paper² (1881) the same writer observed that "the disassociation of the Manchhar and Gáj series is a necessity; and the nature of the fauna, so singularly allied to that of Pikermi, necessitates its relegation to the early Pliocene time." Although there is a little ambiguity in the wording of the sentence, there is no doubt from the context that the beds referred to the early pliocene are the lower Manchhars; and from the use of the word '*necessitates*' the present writer felt bound to adopt that view in the passage already cited.³ In the introduction to a still later work by Prof. Duncan, Mr. W. T. Blanford⁴ prefers, however, to class the lower Siwaliks as of upper miocene age; remarking that the evidence of the fossil corals and echinoderms of Sind is in favour of the classification of the tertiaries in which the lower Siwaliks occupy this geological horizon. It is perhaps on the whole inadvisable at present to press the question too closely.

Owing to the recent changes of view as to the age of some of the later tertiary faunas of Europe, some difficulty has been found in assigning their proper geological ages to many of the European tertiary mammals. In most cases the tables given by Prof. Boyd Dawkins⁵ have been followed; but as the lower pliocene of that writer does not include the Pikermi beds,⁶ these, if referred to the same period, must be regarded as an inferior member, which may be called 'lowest pliocene.' The Eppelsheim beds are classed as upper, and the Sansan and Simorre beds as middle

¹ "Pal. Ind.," Ser. XIV., vol. I., pt. I. ("Sind Fossil Combs, etc.") p. 4.

² "Quart. Journ. Geol. Soc.," vol. XXXVII., p. 207: the italics are the present writer's. ³ The same view has been adopted in the writer's "Geology of Kashmir," "Mem. Geol. Surv. Ind.," vol. XXII.

⁴ "Pal. Ind.," ser. XIV., vol. I., pt. 4 ("Fossil Echinoides of Kachh and Kattywar," p. 2. 1883.)

⁵ Especially the paper in "Quart. Journ. Geol. Soc.," vol. XXXVI., p. 379, *et. seq.*

⁶ With these must be classed the beds of Baitavar (Hungary), Mt. Léberon (France), and Concud (Spain).

miocene: if, as Prof. Duncan¹ thinks probable the Eppelsheim beds are at the base of the pliocene,² then the Sansan and Simorre beds must be transferred to the upper miocene.

Fossil Persian mammals.—It is well to record that from Maragha, in western Persia (nearly due south of Tabriz) fossil remains of mammals have been recently obtained, and named as follows,³ *Helladotherium*. sp. (metacarpal); *Rhinoceros*, sp. (not *tichorhinus*); *Mastodon* (?) sp.; *Tragoceros*, sp. (tibia); and *Hippotherium*, sp.: also *Rhinoceros tichorhinus*, *Elephas primigenius*, *Bos bison*, *Cervus elaphus*, *Equus caballus*, and *E. onager*. It is inferred that these remains probably indicate the presence of the Pikermi beds, together with pleistocene strata. They may possibly also indicate a western extension of the Siwaliks, the fauna of which has a more marked European facies in eastern Balúchistán; and hence render it not improbable that the Siwalik and Pikermi faunas may be eventually brought into actual connection. The occurrence of pleistocene forms in the same region as Pikermi genera is paralleled by the association of Siwalik and Narbada strata in Japan.

¹ 'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 206.

² If this view be eventually maintained the lower Siwaliks would unquestionably be of pliocene age.

³ C. Grewingk, "Über fossile Säugethiere von Maragha in Persia," 'Verh. k. k. geol. Reichs.,' 1881, p. 296.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK RHINOCEROTIDÆ

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

[WITH PLATES I TO X.]

Order: UNGULATA, Div. PERISSODACTYLA,

Family: *RHINOCEROTIDÆ*.

Introductory.—Although in the first volume of this series of the “Palæontologia Indica,” a considerable number of teeth and other remains of various species of rhinoceros, from the tertiaries and post-tertiaries of India and Burma, have been described and figured by Mr. Foote and myself, yet in many cases those remains by no means fully illustrated the dentition and full affinities of the various species, while, from their incompleteness and isolated character, they have in not a few instances led to erroneous inferences. The comparatively recent acquisition of a much larger series of fossil remains of this family by the Indian Museum from Siwalik strata has now enabled me to give a much fuller account of the dentition of most of the Siwalik species, and to correct such previous determinations as subsequently-acquired information has shown to be erroneous. No additional remains of the pleistocene species have been acquired, and it will, therefore, be unnecessary to refer to them at length in this memoir.

Number of species of Siwalik rhinoceroses.—In the “Fauna Antiqua Sivalensis,” three species of fossil Indian true rhinoceroses, from the plio-miocene or Siwaliks of India, were named, upon the evidence of a fairly complete series of remains; while a fourth species, named on very fragmentary remains, was provisionally referred to the genus *Acerotherium*,—a determination which has subsequently turned out to be correct. The above-mentioned four species have been respectively named *R. paleindicus*, *R. platyrhinus*, *R. sivalensis*, and *A. perimense*. In the first volume of the present work two additional species were described from the evidence

of molar teeth under the names of *R. iravadicus* and *R. planidens*; but it will be shown in the course of this memoir that both these so-called species in reality belong to *A. perimense*: in the instance of *R. planidens*, this has already been demonstrated in the preface to the first volume.

General characters of skulls of the four species.—In the preface to the first volume, it has already been shown what are the leading characters of the skulls and dentition of the three Siwalik species of the genus *Rhinoceros*,¹ and also how these species differ from the living Asiatic forms of the genus, with which there has lately been an attempt to unite them: it will not be necessary, therefore, on this occasion to recapitulate the statements there made. In order, however, to show the general form of the skulls of all the Siwalik fossil species of the family, I have caused to be drawn on a small scale (plates IX and X) restored outlines of their skulls, taken either from original specimens in the Indian Museum, or from casts of those in the British Museum, or from those figured in the "Fauna Antiqua Sivalensis." For the purpose of comparison with these fossil skulls, there are also given outlines of the skulls of the three best determined living species of Asiatic rhinoceroses. The living and fossil Asiatic rhinoceroses, of which the skulls are known,² may be divided for our present purpose into three groups, *viz.*, hornless rhinoceroses, unicorn rhinoceroses, and bicorn rhinoceroses, the figured specimens of which will now shortly be noticed in the above order.

Hornless rhinoceros (Acerotherium).—The only Siwalik species of hornless rhinoceros, referred here to the genus *Acerotherium*, is *A. perimense*, of which the restored skull is drawn in figure 1 of plate IX. The form of this skull distinguishes it at once from the skulls of all the other Indian species of the family. The molars, as will be shown below, are of a simple type, approaching those of the Sumatran and Javan rhinoceroses.

Unicorn rhinoceroses.—Of the unicorn rhinoceroses, solely composing the genus *Rhinoceros*³ as restricted by many modern writers, there are four well-determined recent and fossil Asiatic species of which the skulls are known; these are figured on plate X. Fig. 1 is *R. indicus*; 2, *R. javanicus (sondaicus)*; 3, *R. palæindicus*; and 4, *R. sivalensis*. Apart from the differences in the general outline of the skull, *R. indicus* is distinguished from all by the complex pattern of its upper molars, which have a large 'combing-plate' and three 'fossettes' when worn. *R. palæindicus* and *R. sivalensis* are distinguished readily by the form of their upper molars, as is noticed in the preceding volume and in the sequel. *R. palæindicus* differs equally in this respect from *R. javanicus*. *R. sivalensis* and *R. javanicus*

¹ This generic term is used in the original wide sense given it by Linné. The modern sub-divisions are frequently inapplicable in the case of fossils.

² The skull of *R. deccanensis* (Footo) is unknown; judging, however, from the form of the lower jaw, it is probable that this was a bicorn species.

³ Apparently by an oversight, Professor Cope includes the bicorn *R. platyrhinus* in his list of the restricted genus *Rhinoceros* ("Bul. U. S. Geol. Geog. Surv." Vol. V, p. 229). This may have originated from a statement by Professor Flower (P. Z. S., 1876, p. 457) that all the Siwalik species of *Rhinoceros* were unicorn.

seem to be, on the whole, the most nearly allied, since their teeth are constructed on the same general plan; there is, however, considerable difference in the form of the skulls of the two species.

Bicorn rhinoceroses.—Of the bicorn rhinoceroses, there are figured the skulls of two species¹ on plate IX, viz., *R. platyrhinus*, fig. 2; and *R. sumatrensis*, fig. 3. The former has molars of the complex type of *R. indicus*; and the latter of the simpler type of *R. sivalensis* and *R. javanicus*. The latter belongs to the sub-genus *Ceratorhinus*, and the former possibly to a modification of *Atelodus*.

Value of teeth as indicating affinity.—From the above remarks, it will be seen that in species having the same number of horns, and closely allied in other respects,² there may be very great differences in the form of the upper molars; and it, therefore, seems that the structure of these teeth cannot be considered of much value in the determination of the affinities of fossil species.

Number of species of Rhinoceros and Acerotherium.—In order to avoid the necessity of quoting species of *Rhinoceros* and *Acerotherium* by more than one name, owing to the great amount of synonymy that prevails in these genera, the following lists of species with the synonyms has been compiled. The names therein used as the names of the species will be employed in this volume, irrespective of the question whether they all are selected according to strict priority. Doubtful or insufficiently-determined species have prefixed to them a note of interrogation. The memoirs of Messrs. Brandt, Cope, Dawkins, Falconer, Flower, and Peters have been chiefly consulted in the compilation of this list.

GENUS I: ACEROTHERIUM, Kaup.

(Including APHELOPS, Cope.)

1. ACEROTHERIUM CRASSUM (Leidy. sp.). Miocene (?); N. America.

Aphelops (?) *crassus*, Cope.

Rhinoceros crassus, Leidy.

2. ACEROTHERIUM CROIZETI (Pomel). Miocene; Europe.

3. ACEROTHERIUM FOSSIGER (Cope, sp.). Up. miocene; N. America.

Aphelops fossiger, Cope.

4. ACEROTHERIUM GOLDFUSSEI (Kaup). Mid. miocene; Europe.

Rhinoceros brachypus, Lart. (*teste* Kaup).

„ *goldfussi*, Kaup.

5. ACEROTHERIUM LEMANENSE (Pomel. sp.). Low. miocene; Europe.

Acerotherium lemanense, Dawkins.

Rhinoceros lemanensis, Filhol.

¹ There is no specimen of the skull of *R. lasiotis* (Sch.) available, if indeed this species be distinct from *R. sumatrensis*.

² See Flower, P. Z. S., 1876, p. 443, *et seq.*

6. ACEROTHERIUM INCISIVUM (Kaup). Up. eocene and miocene; Europe.
Acerotherium gannatense, Duvernoy (*teste* Kaup).
 " *tetradactylum*,¹ Gaudry.
 " *lypus*, Duvernoy.
Rhinoceros incisivus, Cuvier (in part).
 " *tetradactylus*, Lartet (*apud* Filhol. and Laurillard).
7. ACEROTHERIUM JEMEZANUS (Cope). Up. miocene; N. America.
Aphelops (?) *jemezianus*, Cope.
8. ACEROTHERIUM MALACORHINUS (Cope). Up. miocene; N. America.
Aphelops malacorhinus, Cope.
9. ACEROTHERIUM MEGALODUS (Cope). Up. miocene; N. America.
Aphelops megalodus, Cope.
10. ACEROTHERIUM MERIDIANUM (Leidy. sp.). Up. miocene; N. America.
Aphelops (?) *meridianus*, Cope.
Rhinoceros meridianus, Leidy.
11. ACEROTHERIUM (?) MINUTUM (Kaup). Quercy phosphorites, and low. miocene; Europe.
Rhinoceros minutus, Cuvier.
 " *pleuroceros*, Duvernoy (*teste* Brandt).
 " *steichoimeneis*, Jüger (*teste* Brandt).
12. ACEROTHERIUM MITE (Cope). Low. miocene; N. America.
13. ACEROTHERIUM OCCIDENTALE (Leidy. sp.). Low. miocene; N. America.
Rhinoceros occidentalis, Leidy.
14. ACEROTHERIUM PACIFICUM (Leidy. sp.). Mid. miocene; N. America.
Rhinoceros pacificus, Leidy.
15. ACEROTHERIUM PERIMENSE (Falc. and Caut.). Mio-pliocene; India and Burma.
Rhinoceros iravadicus, Lydekker.
 " *perimensis*, Falconer and Cautley.
 " *planidens*, Lydekker.
16. ACEROTHERIUM TRUQUIANUM (Cope). Mid. miocene; N. America.

GENUS II: RHINOCEROS (*Linné*).

1. ? RHINOCEROS ANNECTANS (Marsh). Miocene; N. America.
2. RHINOCEROS AURELIANENSIS (Nouel?). Miocene; Europe.
Ceralorhinus aurelianensis, *apud* Cope.
3. ? RHINOCEROS AUSTRIACUS (Peters). Miocene; Europe.

¹ M. Gaudry ("Les Enchaînements du Monde Animal, etc.," p. 47) regards *A. tetradactylum* as distinct from *A. incisivum*.

4. RHINOCEROS BICORNIS (Linné). Recent; Africa.
Atelodus bicornis, Pomel.
Rhinaster bicornis, Gray.
 „ *keitloa*, Gray.
Rhinoceros africanus, Cuvier.
 „ *bicornis capensis*, P. Camper
 „ *brucei*, Blainville.
 „ *camperi*, Schinz.
 „ *keitloa*, A. Smith.
 „ *niger*, Schinz.
5. ? RHINOCEROS CIMOGORRIENSIS (Lartet). Low. miocene; Europe.
6. ? RHINOCEROS CUCULATUS (Wagner). Recent; Hab. unknown.
Ceratorhinus cuculatus, Brandt.
7. RHINOCEROS DECCANENSIS (Foote). Pleistocene; India.
Atelodus (?) *deccanensis*, Flower.
8. RHINOCEROS ETRUSCUS (Falconer). Up. pliocene; Europe.
Celodonta etruscus, Cope.
Rhinoceros leptorhinus, Cuvier (in part).
 „ *merki*, Jäger (*teste* Brandt).
9. RHINOCEROS HESPERIUS (Leidy). Miocene (?); N. America.
10. RHINOCEROS INDICUS (Cuvier). Recent and pleistocene; India.
Rhinoceros asiaticus, Blumenbach.
 „ *namadicus*, Lydekker.
 „ *stenocephalus*, Gray.
 „ *unicornis*, Linné.
11. ? RHINOCEROS INERMIS, Lesson. Recent; Asia.
 ? = *R. javanicus*.
12. RHINOCEROS JAVANICUS (F. Cuvier, Geoffrey, and Gray). Recent and (?) pleistocene; ¹ S. E. Asia.
Rhinoceros floweri, Gray.
 „ *javanus*, Cuvier.
 „ *nasalis*, Gray.
 „ *sondaicus*, Cuv. and Horsfield.
13. ? RHINOCEROS LASIOTIS (Slater). Recent; S. E. Asia.
Ceratorhinus lasiotis, Garrod.
 ? = *Rhinoceros smnatrensis*.
14. RHINOCEROS LEPTORHINUS (Owen). Pleistocene; Europe.
Atelodus aymardi, Pomel.
 „ *hemitachius*, Flower.
 „ *merki*, Brandt.

¹ Busk, P. Z. S., 1869, p. 449.

- Calodonta hemitachius*, Cope.
Rhinoceros hemitachius, Falconer.
 ? " *kirkbergensis*, Jäger.
 " *merki*, Jäger and Kaup.
 " *mesotropus*, Aymard, (in part), *teste* Brandt.
 " *priscus*, Falconer.
 " *protichorhinus*, Duvernoy, *teste* Brandt.

15. RHINOCEROS MEGARHINUS (Christol.). Pleistocene; Europe.

- ? *Atelodus elatus*, Pomel.
 " *leptorhinus*, Pomel.
Ceratorhinus monspessulanus, Gray.
Rhinoceros cuvieri, Desmarest.
 ? " *elatus*, Croizet.
 " *leptorhinus*, Cuvier.
 ? " *lunullensis*, Gervais.
 " *mesotropus*, Aymard, (in part), *teste* Falconer.
 " *monspessulanus*, Blainville, in part.
 " *primigenius*, Bronn.

16.? RHINOCEROS NAMADICUS (Falconer and Cautley). Pleistocene; India.

17.? RHINOCEROS OREGONENSIS (Marsh.). Miocene; N. America.

18. RHINOCEROS PACHYGNATHUS (Wagner). Up. miocene; Europe.

- Atelodus pachygnathus*, Flower.
Colodus pachygnathus, Wagner.
Rhinoceros tichorhinus, Duvernoy.

19. RHINOCEROS PALEINDICUS (Falconer and Cautley). Plio-miocene; India.

- Rhinoceros unicornis*, Brandt.

20. RHINOCEROS PLATYRHINUS (Falconer and Cautley). Plio-miocene; India.

- Ceratorhinus sumatrensis*, Brandt.

21. RHINOCEROS RANDANENSIS. (?) Miocene; Europe.

22.? RHINOCEROS SANSANIENSIS (Lartet). Mid. miocene; Europe.

- Dihoplus sansaniensis*, Brandt.
 = *Rhinoceros schleiermacheri*, Kaup, *teste* Duvernoy and Gaudry.

23. RHINOCEROS SCHLEIERMACHERI (Kaup). Miocene; Europe.

- Ceratorhinus schleiermacheri*, Cope.
Dihoplus schleiermacheri, Cope.
Rhinoceros incisivus, Cuvier, in part.
 " *leptodon*, Kaup.
 " *sansaniensis*, Lartet, *apud* Duvernoy.

24.? RHINOCEROS SIMORRENSIS (Lartet). Miocene; Europe.

25. RHINOCEROS SIMUS, (Burchell.) Recent; Africa.

- Atelodus simus*, Pomel.
Ceratotherium oswelli, Gray.
 " *simus*, Gray.

Rhinoceros camus, H. Smith.

„ *oswelli*, Gray.

26.? RHINOCEROS SINENSIS (Owen). Pliocene (?); China.

27. RHINOCEROS SIVALENSIS (Falc. and Caut.). Plio-miocene; India.

Rhinoceros indicus fossilis, Baker and Durand.

„ *unicornis*, Brandt.

Zalabis sivalensis, Cope.

? *Rhinoceros angustirictus*, Falc. and Caut.

28. RHINOCEROS SUMATRENSIS (Cuvier). Recent; S. E. Asia.

Ceratorhinus blythi, Gray.

„ *crossi*, Gray.

„ *niger*, Gray.

„ *sumatranus*, Cope.

„ *sumatrensis*, Gray.

Rhinoceros crossi, Gray.

„ *sumatranus*, Raffles.

29. RHINOCEROS TICHORHINUS (Cuvier and Fischer). Up. pleistocene; Europe.

Atelodus antiquitatis, Brandt.

„ *tichorhinus*, Pomel.

Cælodonta antiquitatis, Cope.

„ *pallasi*, Gray.

Rhinoceros antiquitatis, Blumenbach.

„ *jourdani*, Lartet and Chantre: *teste* Brandt.

„ *lenensis*, Pallas.

„ *mesotropus*, Aymard, in part, *teste* Falconer.

„ *primigenius*, Bronn.

Dentition of the Rhinocerotidæ.—It will be unnecessary on this occasion to enter at length into the consideration of the dental system of the *Rhinocerotidæ*, of which only the two genera, *Rhinoceros* and *Acerotherium*, need be mentioned at all. The main features of the number and general characters of the teeth of these genera will be found given in the “Odontography” of Professor Owen; while certain points in relation to the homology of some of the teeth will be found mentioned in a paper by the author.¹

It will suffice on this occasion to state that in the upper jaw the rhinoceroses above alluded to may, in the permanent dentition, have either one or two pairs of incisors, or may be destitute of any; while there are never any canines. The permanent upper molar series consists of seven teeth, of which the three last are true molars; while of the anterior four, the first may be a milk-molar and the other three premolars, or all four may be premolars. Four milk-molars are always developed.

In the lower jaw there may be no permanent teeth in advance of the premolars, or there may be either one or two pairs of such teeth, in which case the central pair

¹ Jour. As. Soc., Bengal, Vol. XLIX, pt. II, p. 135.

are invariably small and the outer large. The central pair are certainly incisors, and the outer pair also were formerly universally considered as such; there are, however, strong reasons for considering that the latter may really be canines. For the sake of convenience, however, in this volume they will continue to be referred to as incisors, with this proviso. The lower molar series always consists of seven teeth, of which the first four are generally classed as premolars; it is, however, quite possible that the first of these teeth, as in the upper jaw, is in reality a persistent milk-molar. Four milk-molars are developed.

The variations in the permanent dentition of *Rhinoceros* and *Acerotherium* may be expressed by the following general formula:—

$$I. \frac{(0-2)}{(0-2)} - \frac{(0-2)}{(0-2)} \quad C. \frac{0-0}{0-0} \quad MM. \frac{(0-1)}{(0-1?) } - \frac{(0-1)}{(0-1?) } \quad PM. \frac{(3-4)}{(3?-4)} - \frac{(3-4)}{(3?-4)} \quad M. \frac{3-3}{3-3}$$

In describing the teeth of the various species in the sequel, the most anterior of the permanent molar series will usually be referred to as a premolar, irrespective of the question of its true homology.

With regard to the structure of the upper molar teeth, the following terms are applied to the component parts in this memoir. The teeth are supposed to be viewed from the masticating and internal aspects, as in the accompanying figures:—

Anterior collis = large antero-internal column.

Posterior collis = large postero-internal column.

Median valley = hollow dividing the two 'colles.'

Anterior valley = hollow in front of 'anterior collis.'

Posterior valley = hollow behind 'posterior collis.'

Crochet = process projecting from the 'posterior collis' into the 'median valley.'

Combing-plate = process projecting from the outer wall of the tooth into the same.

Ante-crochet = projection on the posterior side of the 'anterior collis.'

Dorsum = outer surface of tooth.

Costa = vertical ridge on 'dorsum.'

Pass = entrance into 'median valley.'

Buttress = projection at the antero-external angle of the crown.

Accessory fossette = separate pit on the worn crown cut off from the outer extremity of the 'median valley.'

Two different types of upper molars.—The upper molars of most species of *Rhinoceros* and *Acerotherium* easily fall into two main divisions, according to their structure. Those of one type, which may be called the Sumatran type, occur in the living Sumatran and Javan rhinoceroses, and are characterised by the production of the antero-external angle of the crown into a strong 'buttress,' or column, which renders the outer wall of the tooth very sinuous. A characteristic tooth of this type is represented in figure 3 of plate III. No teeth of this type ever present an 'accessory fossette' caused by the union of the 'crochet' and 'combing-plate.' The second type of molar is represented in the large living Indian rhinoceros and in the African rhinoceroses; it is characterised by the absence of the 'buttress,' whence the external wall is approximately straight. Teeth of this type are repre-

sented on plate VIII. Very generally, in this type an 'accessory fossette,' formed in the manner noted above, is present; while a 'crochet' and 'combing-plate' seem to be always present, whether they unite or not. In certain species, as in the Siwalik *R. paleindicus*, the upper molars seem to be intermediate in character between those of the two types mentioned above; these will be occasionally referred to below as the 'intermediate type.'

GENUS I. ACEROTHERIUM, Kaup.

(Including APHELOPS, Cope.)

The genus *Acerotherium* (with which Professor Cope's genus *Aphelops* is included), established in 1832 by the late Professor Kaup¹ for the reception of a hornless and anteriorly four-toed species of rhinoceros, may be shortly defined as follows:—No horns in either sex; nasals thin and pointed, and their upper surface not differentiated from that of the frontals. Anterior limbs either tri—or tetradactyle; incisors present in both jaws.²

Species: *ACEROTHERIUM PERIMENSE*, Falconer & Cautley sp.

Synonyms: RHINOCEROS (*ACEROTHERIUM*?) *perimensis*, Falc. & Caut.
RHINOCEROS *PLANIDENS*, Nobis.
RHINOCEROS *IRAVADICUS*, Nobis.

Earlier notices.—The present species of hornless rhinoceros was first named by Falconer and Cautley on the evidence of some mostly imperfect molars, and a part of a lower jaw obtained from the ossiferous beds of Perim Island, in the gulf of Cambay. These specimens are figured in plate LXXV of the "Fauna Antiqua Sivalensis," and their provisional or hypothetical reference to the genus *Acero-*

¹ "Isis," Dresden, 1832.—The definition of the genus here given is adapted from the one given by the late Professor Brandt (Mem. d. l. Acad. Imp. d. S. Pet., Ser. VII., Vol. XXVI, p. 27). Following Professor Brandt, the genus *Aphelops* of Professor Cope, distinguished from *Acerotherium* by having three in place of four digits on the fore-limb, is here included in *Acerotherium*, as in the majority of cases the number of digits cannot be determined.

² According to Professor Cope ("Bul. U. S. Geol. Geog. Survey," Vol. V, p. 235), the genus *Acerotherium* is characterised by the presence of two pairs of both upper and lower incisors (the outer pair of the latter termed canines) and by the non-union of the post-tympanic and post-glenoidal processes of the squamosal below the external auditory meatus. With regard to the presence of two pairs of upper incisors being characteristic of the genus, it may first of all be observed that two pairs of these teeth are developed in *Rhinoceros schleiermacheri* (Kaup, "Oss. Foss. d. Darmstadt," pl. X, fig. 1), and occasionally in *R. indicus* (Lydekker, J. A. S. B., Vol. XLIX, pt. II, pl. VII, fig. 1); and secondly, that in *Acerotherium incisium* there appears to be only one pair of upper incisors, as I judge from a cast of a skull in the Indian Museum, and from the figure given by Professor Gaudry ("Les Enchaînements du Monde Animal, etc." p. 47, fig. 38)! Again, in the lower jaw of the same species, only the outer pair of incisors (canines) seem to be developed (see Gaudry, *loc. cit.*, p. 51, fig. 46); and only this pair are present in the Indian *A. perimensense*. As far as I am able to judge from the cast of the skull of *A. incisium*, the post-tympanic and post-glenoidal processes appear to be united inferiorly. Professor Cope is therefore, to say the least, unfortunate in the characters he has selected for generic distinction.

therium is only one among many other striking instances of the palæontological acumen of the talented authors of that work. At a later period, some other teeth of a rhinoceros from the same beds in the collection of the Asiatic Society of Bengal,¹ were catalogued by Dr. Falconer under the heading *Rhinoceros*, without the affix of any specific name. Dr. Murchison, however, in the "Palæontological Memoirs"² quotes these specimens as *Rhinoceros perimensis*, apparently on no better grounds than the locality from whence they came. Some (and perhaps all) of the specimens do, however, certainly belong to that species.

At a still later period, some detached teeth of a rhinoceros, belonging to the upper molar series, were described and figured by myself in the first volume of this series,³ under the name of *Acerotherium perimense*. It, however, unfortunately happened that these teeth were wrongly placed in the series, and that some were classed as molars, which were really premolars. Although this error has been corrected in the preface and revised description of the plates of the first volume, it has been partly the cause of other errors, and the foundation of some unnecessary species. In the same volume there were also described and figured two incomplete upper molars of a Sivalik rhinoceros, under the name of *R. planidens*,⁴ on the supposition that they belonged to a new species; while, not long after, some complete upper molars, an upper incisor, and the greater portion of a mandible were noticed in the "Records"⁵ under the same name. After all these notices had appeared, the discovery by Mr. Theobald of a nearly complete cranium of a hornless rhinoceros, together with a separate but more complete specimen of the upper molar dentition, alluded to in the "Records,"⁶ conclusively showed that all the specimens referred to the so-called *R. planidens* in reality belonged to *Acerotherium perimense*, and also confirmed the generic distinctness of this form. These specimens, moreover, showed the error which had been made in the serial determination of the previous specimens described by myself under the latter name. In the preface and reissue of the description of certain of the plates of the first volume of this series, all the above-mentioned errors were corrected.

In the same volume,⁷ two upper molars and the occiput of a rhinoceros from Burma were described and figured under the name of *R. iravadicus*, as they could not then be referred to any of Falconer's species. Now, however, the new specimens have rendered it certain that these specimens likewise belong to *Acerotherium perimense*, though to a small-sized variety. It required the large series of specimens now possessed by the Indian Museum to show that the variations from a common standard occurring in many of these teeth were merely varietal forms. The two specimens of milk-molars figured in figure 4 of plate V of the first volume, and referred in the preface to *R. iravadicus* will also be shown in the sequel to belong, in all probability, to *A. perimense*. In consequence of the above re-determinations,

¹ "Cat. Fos. Rem. Vert., Mus. A. S. B." Calcutta, 1859, p. 195.

² Vol. I, p. 171.

³ P. 51, pl. VI, figs. 2, 5.

⁴ P. 41, pl. V, figs. 7 and 9.

⁵ Vol. XI, p. 95.

⁶ Vol. XII, p. 47.

⁷ P. 18, pl. V, figs. 1, 2, 3.

the species *R. planidens* and *R. iravadicus* must be removed from the list of Siwalik mammals.

In figure 1 of plate XL of volume II of the second series of the "Transactions of the Geological Society," two teeth of the upper molar series of a rhinoceros were figured, without being specifically named, by the late Mr. Clift. These teeth belong to the present species, as was noticed in the first volume.

This completes the list of previous notices of the species, and I, therefore, now proceed to describe the new specimens forming the subject of the present memoir.

Cranium.—The cranium, of which two views are given on plate I of this volume, was obtained in the year 1878 by Mr. Theobald from the Siwaliks of the Punjab, and is the specimen referred to in the passage of the XIIth volume of the "Records" already quoted. Before proceeding to describe the specimen, it will be well to mention the grounds on which it is identified with *Acerotherium perimense* of Falconer and Cautley.¹ The figured cranium contains a series of seven molar teeth, all much worn down, and thereby showing that the cranium belonged to a fully adult individual. These teeth being so much worn down and partly concealed by closely adhering matrix, are not calculated to afford a satisfactory figure, and accordingly the left upper molar series of a rhinoceros containing precisely similar, though less worn, teeth has been lithographed (pl. II) in order to illustrate the dentition of this species. In the figured series of molars, if the second tooth from the left, being the second premolar, be compared with the perfect upper premolar of *Acerotherium perimense* figured by Falconer and Cautley,² the two will be found to be identical in general characters, the only difference being that the 'cingulum' is crenulated in the one specimen and simple in the other; this, however, will subsequently be shown to be a variable character. On the similarity of these two teeth depends the identification of all the specimens treated of in this volume with *Acerotherium perimense* of Falconer and Cautley. This identification also fixes the serial position of Falconer's specimen, which had hitherto been uncertain. Dismissing for a time the dentition, we may revert to the consideration and description of the cranium. The specimen is more perfect than is usually the case with the larger Siwalik fossils, but has still sustained considerable injuries. It lacks the extremity of the nasals and of the maxillæ; while the premaxillæ are, of course, likewise wanting. Both zygomæ have been broken away near their origin, and the processes of the squamosal region of the lower aspect have also disappeared. The teeth are a good deal battered, and the ridges bounding the temporal fossæ have also suffered. Pressure has, moreover, somewhat interfered with the original symmetry of the skull, as is shown in figure 2. As before said, the teeth indicate that the cranium belonged to an aged animal—an inference confirmed by the total obliteration of all the cranial sutures.

¹ Here and subsequently I allude to the species as an *Acerotherium*.

² F. A. S., pl. LXXV, fig 15. In the description of this plate the number of this specimen is given wrongly as fig. 14.

If the skull be compared with that of one of any of the living species of rhinoceros, it is firstly remarkable for its gigantic size. The next point that strikes the observer is the great width and flatness of the fronto-parietal region, which forms a nearly smooth triangular surface, with its base below (pl. I, fig. 2). The great width of this surface in the neighbourhood of the occipital crest is especially notable. Some distance behind the orbit, there occurs on this surface a small median oval-shaped elevation, succeeded by a slight depression. It has occurred to me as just possible that this elevation may have carried a rudiment of a posterior horn. The profile is nearly straight as far as the fronto-nasal suture, where there occurs a sharp bend, the planes of the nasals and frontals forming an obtuse angle with each other. The portion of the nasals remaining shows that these bones are transversely arched their sides being situated almost at right angles to their upper surface: when complete they must have been short, straight, and pointed. They are perfectly smooth superiorly, showing no trace of the roughened and longitudinally-arched form so characteristic of the living forms of rhinoceros. The form and condition of these bones also shows that the animal had no trace of any anterior horn, and the species is accordingly referred to the genus *Acerotherium*, as defined above. The orbit is of great size, and the vertical thickness of the skull in the region of the orbit is also a noticeable point. There do not appear to be any other points calling for especial notice in the general form of the skull. From the obliteration of the sutures and the somewhat battered condition of the specimen, the relations of the component bones cannot be determined: this renders it impossible to say whether the bones surrounding the external auditory meatus corresponded to the type of *R. indicus* and *R. javanicus*, or to that of *R. sumatrensis* and the African rhinoceroses.

Dimensions of cranium.—In the following table, the dimensions of the figured cranium are given in the first column, while in the second are given such of the corresponding dimensions of the original skull of the European *Acerotherium incisivum* as occur in Kaup's description;¹ the original dimensions were given by Kaup in millimetres, but have here been converted into inches and tenths for convenience of comparison:—

Length from occiput to tip of nasals	19.0 (broken)	19.6
Height of occiput from base of foramen magnum to crest	10.0	8.6
Greatest width of occiput	12.0	
Breadth at postorbital process of frontals	10.5	6.8
Interval between anterior angle of orbit and auditory fissure	13.2	9.5
" " " extremities of zygoma	12.5	
Vertical diameter of orbit	3.7	
Breadth of base of nasals	4.0	
Length of seven molars	14.6	10.0
Interval between inner surfaces of the first of the molar series	3.0	3.3
" " " " " last " " "	4.4	3.3
Long diameter of occipital condyle	3.2	

¹ "Ossements Fossiles d. Mus. d. Darmstadt," pt. III, p. 36. Darmstadt, 1834.

Comparison with A. incisivum.—From the foregoing table of measurements it will be apparent that the cranium of *A. perimense* is of considerably larger size than that of *A. incisivum*, and that the two crania differ in the relative inclination of the molar series. For the purpose of making a better comparison with Kaup's figure of the skull of the latter species,¹ a reduced and restored figure of the skull of the Indian species is given in figure 1 of plate IX. On comparing these two figures, it will be observed that there is a very considerable difference in the profiles of the two skulls. The nasals of the Indian specimen are much thicker at the base, and, as far as can be inferred from the portion remaining, shorter and more wedge-shaped laterally, than those of the European form. The orbit in the former is more closely approximated to the median plane of the frontals than in the latter, and there is consequently a greater depth from the dental border of the orbit to the teeth. The temporal fossa is wider and shorter in the Indian than in the European form, in consequence of which the distance from the anterior border of the orbit to the occipital crest is proportionately greater in the latter. Other minor differences might be indicated, but the above-mentioned, taken together with the great difference in the form of the teeth, which will be subsequently described, show that the two forms are markedly distinct.

Other European species.—There is still considerable doubt how many species of fossil European rhinoceroses should be referred to the genus *Acerotherium*. The late Professor J. F. Brandt, in his synopsis of the living and fossil species of rhinoceroses and their allies,² only admits two European species, in addition to *A. incisivum*, which are provisionally referred to the same genus. Of one of these,—*A. goldfussi*,—the cranium is, I believe, still unknown; while of the other, *A. minutum*, the cranium has been figured by Kaup,³ and, under the name of *Rhinoceros pleuroceros*, by Duvernoy.⁴ The latter figure shows that the skull is of much smaller size than our Indian specimen, and that the nasals are much longer, more highly arched, and not impossibly bore a very minute anterior horn. There appears to be some doubt whether *Rhinoceros aurelianensis* (Nouel?) of the European miocene should not be referred to *Acerotherium*: Professor Gaudry,⁵ however, thinks it was probably furnished with a small horn.⁶ The nasals are more developed, and the profile of the skull less concave than in *A. perimense*. According to M. H. Filhol,⁷ *Acerotherium* (*Rhinoceros*) *lemanense* and *A. croizeti* are characterised by a peculiarity in the molars, which will be alluded to below: the latter is further distinguished from the present species by its greatly inferior dimensions.

¹ *Loc. cit.*, pl. X, fig. 2. ² "Mem. d. l'Acad. Imp. d. Sci. d. S. Pet.," Ser. 7, Vol. XXVI, pt. IV.

³ "Beitrage zur näher Kennt. d. urwelt. Säuget.," 1854, pt. 1, pl. VIIL.

⁴ "Arch. d. Mus. d'Hist. Nat.," Vol. VII, pl. I, fig. 2a.

⁵ "Les Enchainements du Monde Animal, etc.," p. 18, fig. 39.

⁶ Professor Cope (*loc. cit.*, p. 229) refers this species to the group *Ceratorhinus*: it is very difficult to see on what grounds this determination is made.

⁷ "Ann. d. Sci. Geol.," Vol. XI, pp. 78-79.

American acerotheria.—In the foregoing list of the species of the genus *Acerotherium* (with which is combined the genus *Aphelops* of Professor Cope) there are enumerated ten American species of rhinoceros provisionally referred to that genus, namely, *A. crassum*, *A. fossiger*, *A. jemezianus*, *A. malacorhinus*, *A. megalodus*, *A. meridianum*, *A. mite*, *A. occidentale*, *A. pacificum* and *A. truquianum*.¹ But few of these American species of acerotheria appear to be represented by complete crania, and any comparison between them and the Indian representative of the genus must consequently be deferred till the upper molars of the latter have been described.

Upper molar dentition.—The fine specimen of the left upper maxilla of a rhinoceros, of which the dentition is represented in plate II, was obtained by Mr. Theobald in the Siwaliks of the Punjab, and is the specimen already alluded to. As noticed above, the molar teeth in this jaw correspond exactly with those of the skull just described; but being less worn, and in a better state of preservation, have been selected for figuring. The specimen exhibits the four teeth of the premolar series, in the last of which the outer wall has been somewhat damaged; and the first, and a considerable portion of the second, true molar. In advance of the first tooth of the molar series, the section of the jaw exhibits the root of an incisor tooth. The second, third, and fourth teeth (counting from the left) are seen to belong to the premolar, and not to the milk-molar series, from the fact of the fourth tooth being less worn than the fifth,—the first true molar.

1st premolar.—The first tooth is of an irregularly triangular shape, and of relatively large size; its crown is considerably more worn down than that of the succeeding tooth, and the whole tooth is more elevated above its alveolus than any of the others. It is, therefore, not improbable that this tooth in reality is the first of the milk-molar series, which has never been replaced by a premolar; it is, however, more convenient to refer to it as the first premolar.²

2nd premolar.—The second premolar has an approximately square-shaped crown: the 'anterior collis' is smaller than the posterior, and there is no distinct 'crochet' in the 'median valley.' A very well-marked sinuous and crenulated 'cingulum' surrounds the greater part of three sides of the crown: this 'cingulum' on the inner side rises high above the entrance to the 'median valley.' The 'dorsum,' or external surface of the crown, is nearly flat, but presents a slight tendency to be thrown into vertical folds at its antero-external angle. This tooth corresponds almost exactly to the left upper premolar figured in the "Fauna Antiqua Sivalensis"³ under the name of *Rhinoceros (Acerotherium) perimense*, and, as already

¹ In his last paper on the extinct rhinocerotidæ of America (*loc. cit.*) Professor Cope omits some of the above mentioned species; it is, however, not stated on what grounds these omissions are made, and they are accordingly all mentioned in this work. As well-established species like *R. deccanensis* and *A. perimense* are likewise omitted from the same list, it may be that the other omissions are due to want of care, though this seems strange, seeing that several of them were named by the author of the paper in question.

² For the homology and replacement of this tooth, see the above-quoted paper by the author in the "Journal of the Asiatic Society of Bengal," Vol. XLIX, pt. II, p. 135.

³ Pl. LXXV, fig. 15 (numbered 14 in description of plate).

mentioned, it is on this identification that the specific determination of the cranium and other teeth of this species depends. The tooth figured by Falconer is drawn of half the natural size, and is slightly smaller than our specimen. The former further differs from the latter, in that the 'cingulum' is not distinctly crenulated, and that on the inner side it bends outwards into the entrance of the 'median valley,' in place of passing straight across it. These, however, are trifling differences, and a specimen of the corresponding tooth figured by myself in the preceding volume of this series¹ is intermediate in these respects between the other two homologous teeth, the 'cingulum' being partly crenulated, and extending a short distance into the 'median valley.' In the figure in the previous volume last referred to, two molars are drawn, and these were originally considered to be respectively the last premolar and the first true molar, in place of the second and third premolars. The grounds of this determination were, *firstly*, that the serial position of Falconer's figured premolar was unknown; and, *secondly*, that of my own two figured specimens, the smaller, or anterior tooth, as is stated on page 51 (33) of the first volume, is less worn than the larger and succeeding tooth (right side of figure). In normal cases this would indicate that the smaller tooth was the last premolar, and the larger the first true molar, and accordingly the teeth were so reckoned. The present complete specimen of the dentition has, however, shown that this determination was erroneous, and that consequently the degree of relative wear of the two teeth figured in the first volume must be due to some abnormality in the time of their appearance above the gum. The teeth figured in the first volume being reckoned, respectively, as the last premolar and the first true molar, it was on that supposition totally impossible that the true molars referred in that volume to *R. planidens* could belong to *Acerotherium perimense*, and they were accordingly assigned to a new species.

Another incomplete specimen of a second upper premolar, which has been referred to *Acerotherium perimense*, is drawn in figure 6 of plate VI of volume I. This tooth was originally described as belonging to an unknown species of *Rhinoceros*, and was obtained from the lower Manchhar rocks of Sind. It shows a wavy but uncrenulated cingulum passing entirely across the entrance to the 'median valley,' as in the specimen figured in this volume. It, however, presents a distinct 'crochet,' which is wanting in the other figured specimens, though there seems, judging from other teeth, to be some range of variability in this respect. The determination of this tooth is, therefore, still open to a certain degree of doubt. The first of the two upper molars of a fossil rhinoceros from Burma figured by Mr. Clift,² and already referred to, corresponds in general form with the second upper premolar of *A. perimense*, and is consequently referred to that species;³ the second tooth in Mr. Clift's figure will consequently be the third upper premolar. In the second premolar, as far as can be inferred from the figure, the 'cingulum' is less developed in both teeth

¹ Pl. VI. fig. 5. ² "Trans. Geol. Soc.," 2nd Ser., vol. II., pl. XL., fig. 1.

³ This determination was first made in the first volume of this series (p. 52), but the serial position of the two teeth was incorrectly determined.

than in the specimen figured in this volume, and more resembles the specimen figured in the first volume of this series. From the comparison of the various available specimens of the second upper premolar of the present species, it will be apparent that slight variations in the form of the 'cingulum' of this tooth may occur, which cannot be reckoned as of greater importance than mere individual characters.

3rd premolar.—The penultimate premolar, the third tooth from the left in the figure, is of considerably larger dimensions than either of the preceding, its transverse diameter being greater than the longitudinal. In this tooth, as in all the succeeding ones, the 'anterior collis' is stouter than the posterior. The 'pass' into the 'median valley' is situated at a considerable distance within the mouth of the valley, the latter becoming suddenly very deep behind the 'pass.' When worn down, this tooth, like the succeeding teeth, would present two 'fossettes' on the crown (formed by the outer part of the 'median valley,' and by the 'posterior valley'), and a notch on the inner border (formed by the outer half of the 'median valley'). The 'cingulum' is distinctly crenulated, and occupies the greater portion of three sides of the crown; it is, however, interrupted on the inner surface of the 'posterior collis.' There is no distinct 'crochet,' but there is a rudimentary 'combing-plate.' The 'dorsum' of this tooth is nearly flat, but shows a tendency to the development of a 'buttress' at its antero-external angle. This tooth corresponds very closely with two specimens of the corresponding tooth drawn in figures 2 and 5 of plate VI of the first volume of this work. In the former of those specimens, however, the 'crochet' is more distinctly developed, and the antero-external angle of the crown more bevelled off. Mr. Clift's specimen has been already noticed.

4th premolar.—The last premolar, the fourth tooth from the left in the figure, has much the same general characteristics as the preceding tooth, the main points of difference, irrespective of size, being the greater development of the 'buttress' at the antero-external angle of the crown, and the presence of a distinct 'crochet.'

1st true molar.—The first true molar, the fifth tooth from the left, is distinguished from either of the two preceding teeth by its antero-posterior diameter being greater than the transverse. The antero-external angle of the crown is produced into a well-marked 'buttress,' and the 'dorsal' surface is in consequence considerably sinuated. The 'anterior collis' is of great stoutness, and bears on its anterior surface a vertical groove, while on its posterior surface there is a vertical ridge projecting into the 'median valley,' which may conveniently be termed the 'ante-crochet.' The 'median valley' is wide and spacious, and deepens continually from its entrance, there being no internal 'pass,' as in the premolars: a large and blunt 'crochet' projects obliquely into the 'median valley' from the 'posterior collis.' On the internal face of the tooth, the 'cingulum' is interrupted on the two 'colles,' so as to form three distinct portions,—an anterior, a median, which makes a tubercle at the entrance to the 'median valley,' and a posterior portion. The 'posterior valley' is

large and triangular in shape: the postero-external angle of the tooth is produced into a wedge-shaped process.

Identity with R. planidens.—If this tooth be compared with the two fragmentary upper molars, drawn in figures 7 and 9 of plate IV of the first volume of this work, and upon the evidence of which the new species *R. planidens* was founded, it will be at once apparent that all three teeth belong to the same species.

2nd true molar.—The second true molar in the figured upper dentition is unfortunately so much broken that only its anterior half remains. This portion shows that the tooth had a large antero-external 'buttress,' and that the 'cingulum' was interrupted on the inner surfaces of the two 'colles.' There is a large 'crochet,' and the rudiment of a 'combing-plate,' which, however, does not extend to the base of the 'median valley.' As this tooth is so imperfect, another and complete specimen, also obtained by Mr. Theobald from the Siwaliks of the Punjab, has been drawn in figure 3 of plate III.¹ This tooth agrees very closely in general characters with the second true molar in the previous plate, and is evidently the corresponding tooth of the opposite (right) side of the jaw of the same species. The isolated tooth, however, differs slightly in the form of the 'cingulum' from the corresponding tooth in the full series. This difference consists in the fact of the 'cingulum' being less distinctly crenulated and more closely applied to the surface of the crown, and also that it forms a continuous, although a thin, line along the internal surface of the 'anterior collis.' In respect of the form of the 'median valley,' 'crochet,' and 'colles,' the two teeth are identical.

Identity with R. iravadicus.—If the figure of the above-described second upper true molar of *Acerotherium perimense* (pl. III., fig. 3) be compared with the corresponding tooth of a rhinoceros from Burma, drawn in plate V, fig. 2 of the first volume of this work under the name of *R. iravadicus*, it will be found that in general characters the two teeth are absolutely alike, and they must consequently be referred to the same species. As the last mentioned tooth, together with a corresponding tooth of the opposite side (vol. I., pl. V., fig. 1) were the types on which the species *R. iravadicus* was established, it is evident that this species must be merged in *Acerotherium perimense*. It was impossible, from the materials at hand at the time of publication of the second part of the first volume, to identify the teeth described under the name of *R. iravadicus*, either with those described as *R. planidens*, or with those as *A. perimense*. It has been shown that there is a certain amount of variability in the upper molar teeth of *A. perimense*, and it required a large series of specimens to demonstrate the unity of species of these several varieties. In figure 3 of plate V. of the first volume an imperfect occiput of a rhinoceros from Burma, was also figured under the name of *R. iravadicus*. As far as can be judged from this specimen, it appears to agree very closely in form with the cranium of *A. perimense* described above, and may, therefore, probably be referred to that species.

¹ The specimen was lithographed in my absence, and has unfortunately been placed somewhat out of its proper position.

In figure 4 of the same plate are drawn two upper milk-molars of a rhinoceros, which were also considered in the preface to belong to the same species as the true molars. It will be shown in the sequel that these teeth also may probably be referred to *A. perimense*, so that the name *R. iravadicus* must be withdrawn. As will be seen from an inspection of the figures, the upper molars of *A. perimense* from Burma are of considerably smaller size than those from the Punjab; and, as the same will subsequently be shown to be the case with the milk-molars, it may not be improbable that there existed a smaller Burmese race of the species.

Last upper true molar.—Of the last upper true molar of *Acerotherium perimense*, a specimen from the right side is drawn in figure 5 of plate III. This specimen is one of an associated set of upper molars from Mr. Theobald's Punjab collection. The anterior teeth are in general characters precisely similar to those already figured, and, therefore, need no further mention. The last true molar shows a large 'cingulum' surrounding the 'anterior collis,' the latter being of great size and thickness. A large tubercle, which may be considered as a detached portion of the 'cingulum,' obstructs the entrance to the 'median valley.' The 'posterior collis' is thin, and gives off a distinct 'crochet' projecting into the 'median valley.' The antero-external angle is produced into a strong 'buttress.'

Dimensions of upper molar series.—Having now passed in review the whole of the upper series of molar teeth of this species, we may firstly give the dimensions of the figured specimens, and then proceed to institute comparisons between them and the molars of other species of the genus. The following table gives the dimensions of the five complete anterior teeth drawn in plate II, and of the two later teeth in figures 3 and 5 of plate III:—

Length of first premolar	. . . . .	1.3
Width of " "	. . . . .	1.15
Length of 2nd "	. . . . .	1.6
Width of " "	. . . . .	1.9
Length of 3rd "	. . . . .	1.9
Width of " "	. . . . .	2.8
Length of 4th "	. . . . .	2.2
Width of " "	. . . . .	3.2
Length of 1st true molar	. . . . .	3.2
Width of " "	. . . . .	3.2
Length of 2nd "	. . . . .	3.35
Width of " "	. . . . .	3.3
Length of 3rd "	. . . . .	3.2
Width of " "	. . . . .	3.2

General characters of upper molars.—The foregoing descriptions, with the accompanying plates, will have shown that the teeth of the upper molar series of *Acerotherium perimense* are formed on the general plan of those of the living Sumatran and Javan rhinoceroses (*R. sumatrensis* and *R. javanicus*).

They are characterised by a 'buttress' at the antero-external angle; by a more or less complete 'cingulum,' which always forms a tubercle at the entrance to the 'median valley'; by the presence of a 'crochet,' and by the normal absence of a

'combing-plate' and of a third or 'accessory fossette' on the well worn crown. The 'cingulum' is more developed in the premolars than in the true molars; while the reverse of this arrangement prevails with regard to the 'buttress' and the 'crochet.' Although, as already said, agreeing in general plan with those of the Sumatran and Javan rhinoceros, the molars of the Perim species are at once broadly distinguished by the presence of the large 'cingulum.'

Comparisons with molar series of other species of Siwalik rhinoceros.—Although the cranium of the present species at once distinguishes it from the crania of all the other species of Siwalik rhinoceros, it may be well to point out how the teeth may be distinguished, as they are the remains most frequently met with in the fossil condition. Now that the two so-called species, *R. planidens* and *R. iravadicus*, are shown to be identical with the present species, there only remains *R. platyrhinus*, *R. palæindicus*, and *R. sivalensis* for comparison. The upper molars of the first of these species¹ are formed on the type of *R. indicus*,—that is, they have no external buttress, but a 'combing-plate' and 'accessory fossette' on the worn crown, and are, therefore, totally unlike those of the present species. The upper molars of *R. palæindicus*² have a much less developed 'buttress' at the antero-external angle, a larger 'crochet' extending across the 'median valley,' so as not unfrequently to cut off a third or 'accessory fossette' on the much-worn crown: the 'cingulum' and tubercle at the entrance of the 'median valley' so characteristic of the present species, are in general practically absent in *R. palæindicus*. The upper molar series of *R. sivalensis*³ approaches nearer in general plan of structure to that of the Perim hornless rhinoceros; but the teeth are at once distinguished by the absence of any trace of a 'cingulum' on the inner surface, or of any tubercle at the entrance to the 'median valley.' The 'crochet' of the premolars, as will be noticed below, is, moreover, much more developed in *R. sivalensis*.

Resemblance to R. deccanensis.—In describing the second upper premolar subsequently referred to *Acerotherium perimense* from Sind, but which I was then unable to refer to that species, in the first volume of this series,⁴ I commented upon the resemblance which it presented to the premolars of *Rhinoceros deccanensis* of Mr. Foote,⁵ and consequently inferred that the latter species showed indications of affinity with the older forms of the family,—a very noticeable fact in a pleistocene species. The subsequently-acquired specimens have fully borne out the resemblance between the molars of the two forms. If the figures of the upper premolars given by Mr. Foote be compared with those of *A. perimense* given in this volume, it will be apparent that there is a most marked resemblance between them.⁶ The common features are the large 'cingulum,' and the approxi-

¹ Infra, pl. VIII.

² Pl. VI, fig. 1. F. A. S., pl. LXX, fig. 1.

³ Supra, Vol. I, pl. V, fig. 5.

⁴ Pp. 44—5.

⁵ Supra, Vol. I, p. I, et. seq., pl. I.

⁶ In Mr. Foote's specimen the first premolar is wanting, and therefore the first three teeth in that figure correspond to the second, third, and fourth teeth in my figure.

mation of the bases of the two 'colles.' The 'cingulum' in *R. deccanensis* appears to exist as a more distinct ledge than in the Perim acerotheria, and is not crenulated;—the latter character, however, seems to be a variable one. The 'crochet' is strongly developed in the third premolar of the Deccan rhinoceros, and the buttress at the antero-external of both premolars and molars is very slight, in which respect this species differs from the Perim acerotheria. In the dilapidated condition of the molars of the former, a close comparison would be difficult. The two species were, however, in all probability widely different in their anterior teeth; *R. deccanensis* had certainly no incisors in the lower, and probably none in the upper jaw; while *A. perimense* probably possessed these teeth in both jaws.

Comparison with European acerotheria.—It will be unnecessary to institute a comparison between the upper molars of *Acerotherium perimense* and those of fossil European species of *Rhinoceros*, since the difference in the crania affords abundant ground of distinction; the comparisons are, therefore, confined to the genus *Acerotherium*. The molars of *A. incisivum*,¹ apart from their greatly inferior size, are distinguished by the 'cingulum' being much smaller, more closely applied to the tooth, never crenulated, or interrupted, and not forming a large and distinct tubercle at the entrance to the 'median valley.' The premolars are also more equal in size than are those of the Perim species, and there are numerous minor differences in the form of the teeth of the two species, which can be best understood by an inspection of the figures. The most important of these minor differences is the tendency to the formation of a third, or 'accessory fossette,' in the worn premolars of *A. incisivum*, which is totally wanting in *A. perimense*. Of the upper teeth of *A. goldfussi*, the best figure available is that of a molar given by Kaup.² This tooth appears to have a less completely developed 'cingulum' than the teeth of *A. perimense* figured here, but agrees in this respect more nearly with this part of the teeth of the latter figured in plate VI., figure 5 of volume I. The small figures of upper molars of *A. goldfussi* given by Kaup³ indicate no tubercle at the entrance of the 'median valley;' and no cingulum in the last true molar. The upper molars of *A. minutum*⁴ and *A. croizeti*,⁵ are sufficiently distinguished from those of the present species by their inferior size, as well as by their possessing no distinct 'cingulum' on their inner surface. The molars of *A. croizeti* and *A. lemanense* are, according to M. Filhol,⁶ distinguished by the absence of the 'crochet.'

Dentition of American acerotheria.—Of the ten species of American rhinoceroses provisionally referred to the genus *Acerotherium* noticed above, the upper true molars of *A. crassum*⁷ have no distinct tubercle at the entrance to the 'median valley.' In *A. fossiger*⁸ there is no 'cingulum' to the true molars.

¹ Kaup. "Oss. Foss. d. Mus. d. Darmstadt," pl. xiv, fig. 5.

² Loc. cit., pl. xii., fig. 12.

³ "Beit. zur näher Kennt. d. urwelt. Säuget.," pt. I, pl. II.

⁴ "Oss. Foss. d. mus d. Darmstadt."

⁵ Filhol. *op. cit.*

⁶ *Op cit.*

⁷ "Journ. Acad. Nat. Sci. Philad.," 2nd ser., vol. vii., pl. xiii, fig. 8.

⁸ "Bul. U. S. Geol. Geog. Surv.," vol. v., p. 237.

A. jemezianus,¹ was described upon the evidence of the mandible only, and I do not know whether the upper molars have been subsequently discovered. In *A. malacothrinus*² the 'cingulum' extends continuously round the whole of the inner surface of all the premolars, being never interrupted as in *A. perimense*. In *A. megalodus*, as far as I can gather from Professor Cope's description,³ there is no 'crochet' in the upper true molars, and the 'cingulum' is wanting from the 'posterior collis' of the premolars.

The upper molars of *A. meridianum*⁴ present a considerable resemblance to those of the Indian species. As far, however, as I can judge from the figure, they appear to differ by the greater development of the protuberance from the 'anterior collis' into the 'median valley' in the premolars, and also by the simpler form of the 'cingulum.'

*A. mite*⁵ is readily distinguished from the present species by the fact of the 'colles' ('transverse crests' of Prof. Cope) of the premolars being united on the inner side, and by there being no 'cingulum' on the inner surfaces of the true molars.

In *A. occidentale*⁶ the premolars present a very considerable resemblance to those of the present species; the true molars are, however, readily distinguished by the absence of any distinct 'crochet' and by differences in the form of the 'cingulum.' The upper molars of *A. pacificum*⁷ are characterised by a small and continuous 'cingulum,' and by the absence of a 'crochet,' and 'buttress' at the antero-external angle. Of *A. truquianum* I have been unable to discover a description of the upper molars.

General characters of upper molars.—It has now been shown that, as far as the materials for comparison are available, the Perim Island acerotheres seems to be a distinct species, and consequently, in treating of the other remains referred to that species, it will be unnecessary to institute comparisons between them and those of other species. In the upper molar dentition of *A. perimense*, the most noticeable general points are that the whole dentition is generally less specialised than that of *Rhinoceros*. This want of specialisation is shown in the general completeness and great development of the 'cingulum,' which is more marked in the premolars than in the true molars,⁸ and is a character connecting the genus with the generalised

¹ "Proceedings Acad. Nat. Sci. Philad.," 1875, p. 260.

² "U. S. Geol. Geog. Surv.," vol. v., p. 237.

³ "U. S. Geol. Geog. Surv. of Colorado," 1873, p. 52.

⁴ "U. S. Geol. Surv. W. of 100th Merid.," vol. iv., pl. lxxiii., fig. I.

⁵ "U. S. Geol. Geog. Surv. of Colorado," 1873, p. 494.

⁶ "Jour. Acad. Nat. Sci. Phil.," 2 Ser., Vol. VII., pl. xxii. (*Rhinoceros occidentalis*).

⁷ Leidy, "Contrib. to Ext. Vert. Fauna of West. Territories," U. S. Geol. Surv., pl. II., fig. 6, 7 (*Rhinoceros pacificus*).

⁸ On page 15 of the first volume of this series it is stated by Mr. Foote that "in *R. perimensis*, Falconer, the guard (cingulum) is absent from the upper premolars." It is difficult to see how this statement originated, since the only complete tooth figured by Falconer was a premolar with a most marked 'cingulum.' The premolars of *R. decanensis* in respect of the presence of a large 'cingulum,' approach very closely to those of *A. perimense*; the true molars of the latter have, however, a 'buttress,' which is wanting in the former.

tapiroid and palæotheroid types, such as *Hyracodon*, *Palæotherium*, etc. The same want is shown in the absence of the 'crochet' in the earlier premolars. The absence of any distinct 'combing-plate' indicates affinity with the species of rhinoceros having a molar dentition constructed on the type of that of the Sumatran rhinoceros, a less complex type than that occurring in the tichorhine and Indian rhinoceroses.

Palate from Perim Island.—Since the above descriptions were written, another specimen of the upper dentition of this species has come under the author's notice. The specimen belongs to the museum of the Bombay Branch of the Royal Asiatic Society, and has been already alluded to in another publication of the Survey.¹ It was obtained from the Siwaliks of Perim Island in the gulf of Cambay. By the courtesy of the Council of the above mentioned Society, the specimen has been temporarily lent to the Indian Museum, with permission to describe and figure; and accordingly a figure of the molar dentition of the right side has been intercalated among the plates accompanying this memoir (pl. II A.).

The specimen, which bears numerous recent bivalves on its surface testifying to its place of origin, comprises the greater portion of the palate, exhibiting on the right side all the molar series, with the exception of the first tooth; and on the left, the three true molars only. The molar series of the right side, being the more complete, has been selected for illustration. In the figured series, the first true molar has been considerably damaged, but the remaining five teeth are in a fair state of preservation. A comparison of the additional plate with plate II will at once show that the two series of teeth belong to the same species. The Perim specimen is, however, important from the fact that in all the teeth the 'cingulum' is much less developed than in the Punjab specimen. A similar variation has already been noticed in the case of isolated teeth of the species. The Perim specimen is further important, in that it shows the complete last true molar, but slightly worn,—a tooth lacking in the Punjab specimen.

The dimensions of the Perim specimen are as follows:—

Width of palate between last true molars	5.2
" " 1st " 	4.32
Length of three true molars	7.8
" of molar series (five teeth)	13.2
" of 2nd premolar	2.05
Width of " " 	2.09
" of 3rd " 	2.8
Length of 4th " 	2.2
Width of " " 	3.3
Length of 1st true molar	3.1
Width of " " 	3.4
Length of 2nd " 	3.1
Width of " " 	3.4
Length of 3rd " 	2.09
Width of " " 	3.2

¹ R. G. S. I., Vol. XIV., p. 156.

Upper milk-molars.—In figure 2 of plate III of this volume are drawn two upper molars of a rhinoceros, collected by Mr. Theobald in the Siwaliks, near the village of Asnot, in the Punjab. These teeth are implanted in a fragment of the left maxilla, which also shows the bases of the crowns of other teeth on either side of the two now remaining. Below the broken crown of the tooth on the right side of the figure, there is seen in the jaw the germ of another tooth, which would have replaced vertically the tooth above it. The presence of this germ-tooth in the jaw proves that the tooth above it, and all the teeth in advance of it, must belong to the milk-molar series; consequently, the two figured teeth, as they are in advance of the tooth above the germ, and as they again had another tooth in advance of them, must be the second and third upper milk-molars of a rhinoceros, and it now only remains to consider to what species they belong. Of the three species of Siwalik rhinoceros besides the present, the milk-molars of *R. palaeindicus* are known with tolerable certainty, and will be noticed below. Milk-molars of two other types are also known, and, as will be seen below, are referred with a fair amount of probability, respectively, to *R. sivalensis* and *R. platyrhinus*. There now only remains *A. perimense*, to which the specimens may be referred, and they have accordingly been provisionally so assigned. This identification is rendered the more probable for the following reasons; firstly, the figured specimens come from a district of the Punjab where the remains of *A. perimense* are of extremely common occurrence; secondly, they are of relatively large size, and, therefore, accord well with the permanent teeth of that species; and, thirdly, they belong to the same species as two upper milk-molars from Burma, where only one species of fossil rhinoceros¹ is yet known to have existed. The latter teeth have already been figured in plate V, figure 4 of the first volume of this work, and were originally described on pages 45 and 46 as premolars, but not specifically determined. Subsequently, in the preface to the same volume (p. xiii), it was shown that these teeth were milk-molars, and that they might very probably belong to *R. iravadicus*. Since that species has been shown to be the same as *Acerotherium perimense*, the original inference with regard to the milk-molars would refer them to the latter species.

Description.—Reverting to the specimens figured in this volume, we find that the second milk-molar (*left of figure*) has been broken at its antero-external angle, but is otherwise complete; while the third milk-molar is complete, though slightly obscured by matrix posteriorly. Both teeth are about half worn down. In the smaller tooth, the anterior 'collis' is smaller than the posterior; the reverse being the case in the larger. The 'dorsum' of the smaller tooth shows that it carried, when complete, a single median and vertical ridge or 'costa'; the corresponding surface of

¹ On page 16 of the first volume of this series, it is stated by Mr. Foote that there were probably three species of fossil Burmese rhinoceros, and in support of this he cites three specimens. The first of these are some upper premolars figured by Clift, which correspond to the already described premolars of *A. perimense*. The second specimen is one of those on which *R. iravadicus* was founded, which is now shown to be the same as *A. perimense*. The third is the jaw containing the two associated upper milk-molars noticed above, which also seem to belong to the same species.

the larger tooth was produced into a 'buttress' formed by two similar ridges at the antero-external angle, and also carries a fainter 'costa' opposite the 'posterior collis.' In the smaller tooth there appears to be a small 'combing-plate' projecting from the external wall into the 'median valley' and uniting with the 'crochet'; while the latter extended completely across the valley to join the 'anterior collis.' The union of these processes, in the worn condition of the specimen, has resulted in the formation of three 'fossettes' in the 'median valley.' In the larger tooth there is no 'combing-plate,' and the 'crochet' does not extend completely across the 'median valley.' The 'cingulum' is only distinctly developed on the anterior surface of the teeth, and there is no tubercle at the entrance to the 'median valley.' The dimensions of these two teeth are as follows:—

Length of 2nd milk-molar	.	.	.	.	.	.	.	1.8
Width of " "	.	.	.	.	.	.	.	1.7
Length of 3rd milk-molar	.	.	.	.	.	.	.	2.0
Width of " "	.	.	.	.	.	.	.	2.15

The corresponding teeth of the opposite side from Burma, figured and described in the first volume, are less worn than the present specimens, and are also of somewhat smaller size. In all essential characters, however, the two specimens agree precisely. The 'buttress' at the antero-external angle of the third milk-molar from Burma appears somewhat less developed than in the corresponding Punjab tooth; this, however, is merely due to the difference in the condition of wear of the two specimens.

Comparisons.—On the assumption that the milk-teeth described above belong to *Acerotherium perimense*, it will be apparent that they differ from the teeth of the permanent series by the much slighter development of the 'cingulum,' and by the presence of a 'combing-plate' in the second milk-molar. These differences, however, should not be taken as affording indications of specific distinctness, as it appears to be not unfrequently the case that in animals of this family the milk-molars differ somewhat from the permanent teeth. Very analogous differences are to be observed between the permanent and the milk-molars of the living African *R. bicornis* as figured by De Blainville.¹ In that species the upper true molars show a distinct 'cingulum,' and either a very small or no 'combing-plate.' In the milk-molars, on the other hand, there is scarcely any 'cingulum,' and a large 'combing-plate.'

Upper incisor.—In figure 4 of plate III a very fine specimen of the unworn germ of an upper incisor of a rhinoceros is figured, which must probably be referred to the present species. This specimen was discovered by Mr. Theobald in the Siwaliks of the Punjab, and has been already referred to, under the name of *Rhinoceros planidens* in the "Records."² The grounds of assigning this tooth to *A. perimense* are, firstly, that it was found in the district where remains of that species are of such common occurrence; secondly, the large size of the tooth itself, which renders

¹ "Ostéographie" Atlas, genus *Rhinoceros*.

² Vol. XI, p. 98.

it much too large to have belonged to *R. sivalensis*, which is the other common Punjab species, the large *R. platyrhinus* being apparently unrepresented there'; and, thirdly all the other known species of *Acerotherium* were provided with large upper and lower incisors. The specimen is viewed from the inside, because a great part of the outer surface has been broken away, leaving merely a cast of the pulp-cavity.² The tooth had not cut the gum at the time of the death of its owner, and therefore exhibits its outline to perfection. The lithograph gives a good idea of its form, and as this does not differ in any material point from that of other incisors of the family, no description is necessary. The length of the specimen is 4·3 inches, its thickness 1·5 inches, and the height of the crown 1·9 inches. This tooth indicates an animal of gigantic dimensions. Another very similar, but much worn tooth was also obtained by Mr. Theobald in the same district of the Punjab. It is not possible to say whether *A. perimense* was furnished with a second pair of upper incisors.

Mandible.—The mandible of a rhinoceros of which two portions are figured on plate IV of this volume, is another specimen from Mr. Theobald's Punjab collection. It was obtained from the same district as several of the upper molars of *Acerotherium perimense*, and has been already shortly noticed in the "Records"³ under the name of *Rhinoceros planidens*. The main reasons for assigning it to the present species are, from its association with the upper molars, from its large size, and greatly-developed incisors, so characteristic of the genus *Acerotherium*; and also from the presence of a 'cingulum' on the outer surfaces of the molars, which is likewise, according to Professor Gaudry, a characteristic of that genus.⁴ This reference is confirmed by the fact that three other forms of mandible of rhinoceros have been obtained from the Siwaliks, and have been respectively assigned to the three species of true *Rhinoceros*, in regard to which more will be said in the sequel.

The specimen under consideration consists of two portions, the larger of which (figure 1) comprises the symphysis and a considerable portion of the right ramus of the mandible. This fragment shows four molar teeth, the three first of which are fairly perfect, while the last (m 1) has been considerably injured, only its central portion now remaining. This tooth being more worn than the three earlier teeth must be the first true molar, the other three being the three last of the pre-molar series. On either side of the symphysis there is a single huge incisor: the one on the right side (in) has only lost its tip; while that on the left side has been broken off level with the alveolus, and is not shown in the figure: the outer side of this alveolus exposes the base of this incisor for a length of some five inches, with but little diminution in size. The right incisor shows that the protruded portion presented a flattened surface superiorly, looking upwards and inwards, while the

¹ 'R. G. S. I.,' Vol. XI, p. 95.

² The specimen was lithographed during my absence, and has unfortunately not been drawn in its natural position. The left-hand border should have been placed inferiorly.

³ Vol. XI, p. 97.

⁴ See "Les Enchaînements du Monde Animal, etc.," p. 58.

inferior and external surfaces are rounded: the tooth is strongly curved upwards, and extends above the plane of the grinding surfaces of the molars. A slight fracture of the portion of the symphysis between the two large incisors shows that no small median incisors were present. The bone of the jaw itself is so decayed and mixed up with the closely adherent matrix that it is no easy matter to detect its true form. The ramus is very noticeable for its great vertical depth; and the symphysis seems to be much like that of the Javan rhinoceros, except that the enormous size of the incisives renders its borders more swollen and protuberant.

Of the molar series, the three last premolars and the first true molars, as already stated, are shown in the portion of the right ramus (fig. 1): the fragment of the associated left ramus, represented in figure 2 of the same plate, shows two teeth, which, from their condition of wear, seem to be, respectively, the first and second true molars. The teeth of the molar series resemble those of living species of rhinoceros, with the exception that at the base of their external surfaces they carry a narrow but distinct 'cingulum,' thereby showing, as is pointed out by M. Gaudry in the passage already cited, an affinity with older forms of the order, like *Palæotherium*.

Comparisons and dimensions.—Of the three forms of lower jaws of rhinoceros exhibiting the symphysis, figured in the "Fauna Antiqua Sivalensis," the only one which agrees with the present specimen in the number of its anterior teeth is the one represented in figure 4 of plate LXXIV, which is there referred to *R. palaeindicus*. A more perfect specimen of a similar lower jaw is represented in figure 3 of plate VI of this volume, and is inferred, like the first specimen, to belong rather to *R. sivalensis*. The much smaller size of these specimens, with the absence of a 'cingulum' on the molars, at once distinguishes them from the specimen before us. The dimensions of that specimen are as follows:—

Depth of ramus at last premolar	4.5
Length of symphysis	6.4
Vertical diameter of incisor	1.8
Transverse " " "	2.4
Length of remaining protruded portion of incisor	3.5
" of three premolars	5.1
" of 1st true molar	2.65
" of 2nd " "	2.8

Young jaw.—In figure 1 of plate III of this volume, there is represented an unown tooth-germ of a rhinoceros in its alveolus. This specimen is contained in a fragment of the left ramus of a mandible from which the other teeth have disappeared. The figured tooth, of which the anterior crescent has been somewhat injured, from its large size not improbably belongs to the present species. It was obtained by Mr. Theobald from the Siwaliks of the Punjab, in company with numerous other remains of *Acerotherium perimense*. Behind the figured tooth there exists in the jaw the empty alveolus of a still larger tooth: from the small dimensions of the jaw, it is probable that the tooth remaining is the first true molar. Its

length is 3·3 inches, and the height of the inner column of the hinder crescent 1·9 inches. Other specimens of lower jaws in the Indian Museum from the Punjab, probably also belonging to the present species, have molars of even still larger dimensions.

Specimen figured in the "Fauna Antiqua Sivalensis."—In figure 13 of plate LXXV of the "Fauna Antiqua Sivalensis," a portion of the left ramus of the mandible of a rhinoceros from Perim Island is figured under the name of *R. (A?) perimensis*. This specimen shows the last premolar and the three true molars. In the post-humous descriptions of the plates of the "Fauna Antiqua Sivalensis"¹ the dimensions of the teeth of this specimen are given as follows:—"Length of first true molar, 1·15 inches; of second, 1·4 inches; of third, 1·5 inches." Now these dimensions exactly correspond with the length of the teeth in the figure; but at the bottom of the plate itself it is stated that all the figures are drawn of half the natural size, and I can therefore only come to the conclusion that the dimensions of the teeth are really double those given in the description. Hence we shall have—

Length of 1st true molar	2·3
" of 2nd " "	2·8
" of 3rd " "	3·0

These dimensions are very close to those of the specimens described above, and it, therefore, seems probable that the Perim specimen may be rightly referred to *A. perimense*. There are some signs of a 'cingulum' being represented in the last true molar, but the figure does not show this very clearly. The form of the teeth seems to agree very closely with that of the lower teeth figured in this volume.

Bombay specimen.—Another specimen from Perim Island, belonging to the Bombay Branch of the Royal Asiatic Society, and alluded to in the "Records,"² agrees exactly in dimensions with the above. It consists of the greater part of the left ramus and symphysis of the mandible, and shows most of the molar series. The broken symphysis exhibits a large incisive alveolus.

General characters of species.—The foregoing descriptions will have shown that *Acerotherium perimense* was a very large-sized species of hornless rhinoceros, furnished above with one large pair of incisors, and whose upper molar teeth were formed after the pattern of those of the Javan and Sumatran rhinoceroses, but which presented a less development of the 'crochet.' The lower jaw was provided with one huge pair of outer incisors, and with the normal complement of molar teeth, which were furnished with a distinct 'cingulum' externally.

Distribution.—Remains of *Acerotherium perimense* have been obtained from the ossiferous beds of Perim Island in the Gulf of Cambay, from the lower Manchar beds of Sind, from the Siwaliks of the Punjab, and from the ossiferous beds of the valley of the lower Irawadi. No remains of the species have hitherto been obtained from the Siwaliks in the neighbourhood of Dehra Dûn and the Jamna

¹ "Pal. Mem.," Vol. I, p. 517.

² Vol. XIV, p. 156.

river, and it therefore appears that the Burmese form, which seems to have belonged to a smaller race, was isolated from the other representatives of the species.

GENUS II: RHINOCEROS, *Linné*.

Either one or two horns, or rudiments of such, always present; limbs tridactylate.

Species I. RHINOCEROS SIVALENSIS, Falconer and Cautley

Synonyms (?) RHINOCEROS ANGUSTRICTUS, Falc. and Caut.

„ FOSSILIS INDICUS, Baker and Durand.

ZALABIS SIVALENSIS, Cope.

Previous notices.—The earliest description of a fossil rhinoceros from the Siwaliks is one published by Messrs. Baker and Durand in 1836.¹ In that paper there is described a complete skull, various teeth, and limb-bones,—all illustrated by figures. The authors considered that their skull indicated an animal allied to the living *R. indicus*, and accordingly gave it the name of *R. indicus fossilis*. From their figures and descriptions it is evident that their skull belongs to the species which was subsequently named *R. sivalensis* by Falconer and Cautley. Messrs. Baker and Durand did not apparently closely examine the molars of their specimen, or they would have seen that it was more nearly allied to *R. javanicus* than to *R. indicus*. Messrs. Baker and Durand's paper is copied, without the illustrations, in the "Palæontological Memoirs" of Dr. Falconer.² The teeth of which figures are given in Messrs. Baker and Durand's paper apparently belong, as was suggested by the authors, to more than one species. The present name of the species appears to have been first applied to the specimens figured in the "Fauna Antiqua Sivalensis," which afford ample means of recognising the species. In Royle's "Illustrations of the Botany, &c., of the Himalaya Mountains," published in 1839, there appears a figure³ of the upper jaw and dentition of a rhinoceros from the Siwaliks, which was subsequently copied in the "Fauna Antiqua Sivalensis,"⁴ where it is assigned to the present species. In the "Palæontological Memoirs"⁵ a very cursory notice of this and the other Siwalik species of the genus is given. In the course of that notice the editor quotes a passage from the "Odontography"⁶ of Professor Owen in reference to one of the Siwalik species of rhinoceros, and adds a comment of his own which appears to have been the source of many subsequent errors. Professor Owen's statement is as follows: "In one of the extinct species of rhinoceros from the

¹ J. A. S. B. vol. V, p. 486. In the previous volume of the same journal (vol. IV, p. 706, 1835), among a list of Siwalik mammals given by Falconer and Cautley, occurs the name *Rhinoceros angustirictus*; it is probable that this name was originally applied to the present species, but subsequently replaced by *sivalensis*.

² Vol. I, p. 158

³ Pl. VI, figs. 3, 6.

⁴ Pl. LXXIV, fig. 5.

⁵ Loc. cit., p. 157.

⁶ Page 589.

Himalayan tertiary beds, Dr. Falconer informs me that there are six incisors in both jaws; the typical number was therefore retained in this ancient species as in the contemporary *Hippopotamus* of the same formations." It will be seen from this statement that no species was named in which the peculiarity was said to occur. The late Dr. Murchison (the editor of the "Paleontological Memoirs"), however, goes on to observe that from the evidence of certain lower jaws figured in the "Fauna Antiqua Sivalensis" under the names of *R. palæindicus* and *R. platyrhinus*, the peculiarity could not occur in either of those species, and accordingly says that *R. sivalensis* must be the species in which six incisors were developed. Dr. Murchison, however, entirely omits to mention that in the "Fauna Antiqua Sivalensis" there is figured a third form of lower jaw under the name of *R. sivalensis* in which there are no incisors at all.¹ As no complete set of the upper incisors of any of the species of the Siwalik rhinoceroses is known, there is, as I have already shown in the first volume of this series,² no evidence at all to show that any of the Siwalik species of rhinoceros presented any abnormality in their dentition.³ The next notice of the species, of any importance, occurs in the previous volume of this series, where some molar teeth are described and figured, and where mention is made in the subsequently published preface of some later notices by other writers. In that preface⁴ mention is made of the establishment of a new genus (*Zalabis*), for the reception of *R. sivalensis*, by Professor Cope; and it was then stated that the new genus would not stand, and it might have been added that there were no more grounds for referring *Rhinoceros sivalensis* to it than any other Siwalik representatives of the family, the original statements as to the alleged hexaprododont character of one species having been made to apply to *R. sivalensis* on false premises.⁵ A notice by the late Professor Brandt, in which he proposed to unite this species and the next with *R. indicus*, has been already fully discussed in the preface to the first volume of this work.

Object of present notice.—In the present volume certain teeth, obtained since the notice in the first volume was written, and illustrating more fully the dentition of the species, have been figured. A re-determination of the lower jaw probably belonging to this species has also been made, and an imperfect skull, provisionally referred to a variety of this species, is also noticed.

Penultimate upper true molar.—On page 26 of the first volume of this work a fine specimen of the, probably, penultimate upper true molar of this species was described; the same specimen was also figured in plate V, fig. 5. In that description, however, it was not stated on what grounds the specimen was referred to

¹ Pl. LXXIV, fig. 6.

² Page 53.

³ It is impossible now to say on what grounds this statement of Falconer's rested, but it is quite clear from a passage in his writings said to have been written in 1839 (Pal. Mem. vol. I, p. 180) that at that time, at all events, he considered that no species of rhinoceros had the full complement of mammalian incisors.

⁴ pp. ix, xii.

⁵ Professor Gaudry ("Les Enchainements du Monde Animal, etc.," p. 50) has likewise followed the false lead, and says "D'après Falconer, le *Rhinoceros sivalensis* de l'Inde avait le devant de sa mâchoire inférieure armé de trois paires de dents."

R. sivalensis. These grounds were, firstly, that the tooth agreed, as far as could be judged from the different state of wear of the specimens, with the corresponding tooth of a skull of *R. sivalensis* in the Indian Museum; and secondly, with the corresponding tooth of the left side of a skull of the same species drawn in figure 5 of plate LXXIV of the "Fauna Antiqua Sivalensis," which, though unfortunately figured on a small scale, is a very perfect specimen.

In plate V, figures 1 and 2 of this volume, two specimens of the penultimate upper true molar of this species have been figured in order to illustrate more fully this tooth in different stages of wear, and also to indicate the distribution of the species. The first specimen (figure 1) was obtained by Mr. Theobald from the Siwaliks of the Punjab, and the second by Mr. Fedden from the lower Manchhars of Sind. It will be unnecessary on this occasion to describe these teeth in detail, as this has already been done when treating of the specimen figured in the first volume, above referred to. A comparison of the figures will show that the three specimens present the same general characteristics in spite of some minor individual peculiarities, and the different conditions of their wear. In the latter respect, the Sind specimen is the least worn, the specimen represented in plate V, figure 5 of the first volume rather more worn, and the specimen in plate V, figure 1 of this volume the most so. The latter specimen appears to agree with the original specimen in all characters except the relative development of the 'crochet,' which is very much smaller: I cannot, however, think that this can be reckoned as more than an individual variation. The Sind specimen had originally a well-developed 'crochet,' but this has been broken away, and the point of attachment is difficult to show well in a figure.

This specimen, however, differs from either of the others in having a vertical groove on the posterior aspect of the 'anterior collis' corresponding to a similar groove on the anterior aspect of the same part occurring in all the specimens. Externally to this groove there is a slight swelling of the 'collis' jutting forth into the 'median valley.' The 'posterior valley' of the Sind specimen differs slightly from that of the specimen figured in the first volume. In the latter this valley forms an almost completely circular pit; while in the former its antero-posterior diameter is longer than its transverse: in this respect the specimen drawn in plate V, figure 1 of this volume is intermediate between the other two. A very slight trace of a tubercle can be detected at the entrance to the 'median valley' in the Sind specimen. I cannot consider that these slight variations, in the absence of any other more decisive evidence, can be considered as anything more than individual peculiarities. The variations in the Sind specimen are of considerable importance in identifying other specimens with the present species, as will be seen in the sequel.

Resemblance to R. javanicus.—In the previous volume, it has been mentioned that the upper molars of *R. sivalensis* resemble those of *R. javanicus* and *R. sumatrensis*. Certain points of alleged difference there pointed out seem, however, to be based on individual peculiarities, and are not of general applicability. The re-

semblance is, therefore, much greater than was at first indicated. Professor Flower¹ has pointed out how very closely the molars of the two living species resemble one another, but has shown that in *R. sumatrensis* the 'posterior valley' is relatively deeper than in *R. javanicus*, and consequently that on the worn masticating surface of the former, two 'fossettes' (fossæ) exist for a longer time than in the latter. In this respect the molars of *R. sivalensis* agree with those of *R. javanicus*, the 'posterior valley' being shallower than the median, and consequently the 'posterior fossette' disappearing at an earlier period than the median. This is well shown in the first true molar of the skull figured in plate LXXIV, figure 5 of the "Fauna Antiqua Sivalensis," and in two skulls in the Indian Museum. This being so, and seeing that *R. sumatrensis* is further broadly distinguished by its bicorn character, and by the relations of the inferior processes of the squamosal, we may confine ourselves to a comparison with *R. javanicus*. Between the true molars of these two species, taking into consideration the small variation which I have noticed in those of the fossil, I am totally unable to discover more than one point in their plan of structure which can be taken as affording any certain indication of distinction. This point is a difference in the relative dimensions of the molars of the two species. Taking little worn teeth, we shall find that in *R. sivalensis* the greatest length of the anterior surface, measuring to the second 'costa' of the 'buttress,' is exactly equal to the greatest length of the external surface; whereas in *R. javanicus* the former measurement is greater than the latter. The following measurements show this relationship: the two teeth of *R. sivalensis*, of which the dimensions are given, are the specimens figured in this volume (plate V, fig. 2), and in the preceding volume (plate V, fig. 5): the measurements of *R. javanicus* are taken from the teeth of a skull in the Indian Museum, and from another in my own possession; two other specimens in the former collection present the same characters:—

	<i>R. sivalensis</i>		<i>R. javanicus</i> .	
	a.	b.	a.	b.
Greatest length of outer surface	2.5	2.61	2.0	2.1
„ „ of anterior „	2.49	2.6	2.22	2.32

In all the specimens that I can procure this relation appears to be constant. In the relation of the transverse to the longitudinal diameter, the teeth of *R. sivalensis* agree with those of *R. sumatrensis*, but, as already said, differ in other points. Mr. Busk pointed out this difference in the relative diameters of the teeth of *R. sumatrensis* and *R. javanicus*²; but his conclusions were doubted by Professor Flower.³ In such specimens as I have examined the relation is constant. It might be thought that size alone would afford sufficient grounds of distinction between the molars of *R. sivalensis* and those of *R. javanicus*, but although those of the former species are in general considerably the large of the two, a specimen described in the sequel as a probable variety of *R. sivalensis* has molar teeth of the same size as those of *R. javanicus*. It will be seen from the above comparisons how very closely the upper

¹ P. Z. S., 1876, p. 449.² P. Z. S., 1869, p. 413.³ Loc. cit.

true molars of these two species resemble one another; and it appears to be very questionable whether, if we had only the teeth to deal with, there would be sufficient grounds for specific distinction.¹ This is, however, abundantly afforded by the difference in the form of the skulls.

Germ of upper true molar.—In figure 5 of plate V, there is figured a germ specimen of a first or second upper true molar, presenting all the characters of the teeth of *R. sivalensis*. This specimen was obtained by Mr. Theobald from the Siwaliks of the Punjab, and is quite uninjured. The base of the tooth has not yet attained its full size, but the summits of the ridges are of the same length as in the fully formed teeth of the species. The 'crochet' bifurcates at its extremity, and on the external or 'dorsal' surface of the crown there are seen to be two faint median ridges, which seem to disappear in the adult teeth.

Baker and Durand's specimen.—In figure 8 of plate IV of the first volume of this work, a molar of a Siwalik rhinoceros, copied from one of the plates of the above-quoted memoir of Messrs. Baker and Durand, was figured under the name of *R. sivalensis*. The teeth above described seem to show that the specimen in question must belong to another species, possibly to *R. paleindicus*.

Last upper true molar.—In figure 2 of plate IV of the first volume of this work, there is figured a much worn specimen of the last upper true molar of the present species. That specimen belongs to a cranium in the Indian Museum, agreeing in all respects with the figures of the skulls of *R. sivalensis* given by Messrs. Baker and Durand, and in the "Fauna Antiqua Sivalensis"; the specimen is, however, so much worn that the main characters of the tooth are not well shown, and, accordingly, another and less worn specimen has been figured in the present volume (pl. V, fig. 4). This specimen, which belongs to the left side, was obtained, in company with its fellow of the opposite side, by Mr. Theobald in the Siwaliks of the Punjab: a portion of the summit of the crown has been broken away at its antero-external angle, but the specimen is otherwise uninjured; it is in an early state of wear. The specimen is characterised by the prominent 'buttress' at the antero-external angle, by the simple 'crochet,' absence of 'combing-plate,' and wide 'median valley,' without any trace of a tubercle at the entrance. The 'anterior valley' forms a triangular platform on the side of the 'anterior collis': a faint tubercle at the postero-internal angle of the crown indicates a rudiment of the 'posterior valley,'—a rudiment frequently still more marked in *R. javanicus*. The tooth agrees very closely as regards form with the corresponding molar of the latter species; the following measurements showing the difference in the size of the two specimens:—

		<i>R. sivalensis.</i>	<i>R. javanicus.</i>
Length of internal surface	. . . . .	2.0	1.6
" of anterior "	. . . . .	2.3	1.95
" of external "	. . . . .	2.4	1.9

¹ The similarity of the teeth of these two species induced me to put in a proviso in this respect as to the identification of the Narbada rhinoceros with the living *R. indicus*.—Supra, Vol. I, Preface, p. viii.

The specimen, as far as can be judged from the small figure in the "Fauna Antiqua Sivalensis,"¹ is distinguished from the corresponding molar of *R. paleindicus* by the presence of the large 'buttress' at the antero-external angle, which is wanting in the latter. It is distinguished from the corresponding molar of *R. platyrhinus* by the absence of a 'combing-plate.'

The specimen figured in the preceding volume shows that when worn down only a single 'fossette' would remain on the crown, and this would be the case with the specimen figured here. In the specimen on the opposite side of the skull of which one tooth is figured in the first volume, the 'crochet' extends completely across the 'median valley,' so as to cut off an 'accessory fossette.' A detached specimen of a last upper true molar in the Indian Museum, from the Punjab, apparently belonging to the same species, shows a distinctly double 'crochet.'

Third upper premolar.—The specimen drawn in plate V., figure 6, so closely resembles the third or penultimate right upper premolar of *R. javanicus*, that, judging from the similarity of the true molars of the two species, there can be little doubt but that it is the corresponding tooth of *R. sivalensis*. It was obtained from the Siwaliks of the Punjab by Mr. Theobald: it is quite perfect, and about one-third worn down. The characteristic features of this tooth are the following. The 'posterior valley' forms a funnel-shaped pit, apparently nearly as deep as the 'median valley': the 'anterior collis' is considerably larger than the posterior, and the 'crochet' is double or bifurcate: there is no 'combing-plate.' The external, or dorsal, surface shows two 'costæ,' the posterior of which is slightly, and the anterior very strongly, developed; the antero-external angle is produced into an acute process, and this, together with the anterior 'costa,' shows a tendency to the formation of the 'buttress' so characteristic of the true molars; the whole 'dorsal' surface, however, remains approximately straight, and not highly curved, as in the true molars. There is a faint trace of a 'cingulum' on the internal surface. The following dimensions show the relations of this specimen with the corresponding tooth of *R. javanicus* :—

	<i>R. sivalensis.</i>	<i>R. javanicus.</i>
Length of internal surface	1.2	1.0
" of anterior "	2.1	1.8
" of external "	1.6	1.5
" of posterior "	1.7	1.6

Almost the only difference that can be detected between these two teeth is that in the fossil species the double 'crochet' is thicker and larger than in the living. According to Professor Flower² the double 'crochet' of the premolars of *R. javanicus* is a distinctive character of that species; never occurring in, the otherwise very similar, teeth of *R. sumatrensis*. The occurrence of a similar peculiarity in (at all events some of) the premolars of *R. sivalensis* is another indication of the close affinity of that species with the Javan rhinoceros. It may be added that some

¹ Pl. LXXIV, fig. 2a.

² Loc. cit. p. 449.

skulls of *R. javanicus* in the Indian Museum show a double 'crochet' in the first true molar; and we have seen a probable instance of the same in the last true molar of *R. sivalensis*.

Second upper premolar.—The last specimen of the permanent upper dentition of this species, we have to consider, is the specimen represented in plate V, figure 3. This tooth is also from Mr. Theobald's Punjab collection: it is much worn down. From its general resemblance to the second (ante-penultimate) left upper premolar of *R. javanicus*, it is inferred to be probably the corresponding tooth of *R. sivalensis*. The tooth clearly exhibits the much smaller depth of the posterior as compared with the 'median valley'; the former being nearly obliterated, and the latter still very deep. The only points by which this specimen can be distinguished from the corresponding tooth of the Javan rhinoceros are its larger size, and the somewhat greater development of the 'cingulum' on the internal surface.

Upper milk-molars.—In figure 2 of plate VI are represented three upper milk-molar teeth of a rhinoceros, obtained by Mr. Theobald from the Siwaliks of the Punjab, and probably belonging to *R. sivalensis*. The specimens figured are from the left side of the skull, but the corresponding teeth of the opposite side were also found with them. With regard to the species to which these teeth should be referred, it will be seen from what has been previously written that they do not belong to *Acerotherium perimense*; it will be shown subsequently that they certainly do not belong to *R. palaeindicus*; while from the absence of a 'combing-plate' in the hindmost, they do not belong to *R. platyrhinus*, an inference confirmed by the absence hitherto of all remains of that species in the Punjab. There accordingly only remains *R. sivalensis*, to which they can be assigned; and we have, therefore, only to consider the serial position of these teeth. From the antero-posteriorly elongated form of the anterior tooth (mm. 2), it might at first sight be thought that the teeth are the first three of the milk-molar series, but the complex form of the first tooth (having complete anterior and posterior 'colles'), together with the form of the second tooth, seems to forbid this view. In respect to the latter point, it may be observed that there are no instances known to me in which the second upper milk-molar of a rhinoceros has the anterior 'costa' approximated to the antero-external angle (as in the middle tooth, mm. 3 of our specimen); the position of this 'costa' being central, or sub-central if distinctly developed at all. It seems, therefore, that the teeth under consideration are (reckoning from left to right) respectively, the second, third, and fourth of the deciduous series. On this assumption the first milk-molar must have been an exceedingly small tooth, and was probably shed in very early life.¹ In this respect, *R. sivalensis* agrees with *R. javanicus*, which is distinguished from *R. indicus* by the smaller size of this tooth, and by the earlier time at which it is shed.

The second milk-molar (mm. 2 in figure 2) is an irregularly-shaped tooth,

¹ A very minute undescribed tooth in the Indian Museum is not improbably the first upper milk-molar of this species.

the anterior side being produced into a sharp process; posteriorly to this process the external surface is convex, showing two faint 'costæ' opposite the 'collis.' The 'anterior collis' is flattened internally, and throws off an oblique ridge to join the outer wall of the tooth: from the ridge connecting the 'posterior collis' with the outer wall, there is given off a long 'crochet,' projecting into the 'median valley.' There is a distinct 'cingulum' on the anterior and posterior walls of the tooth. The third and fourth (penultimate and last) milk-molars resemble normal rhinoceros molars, and, therefore, require no detailed description. In the penultimate tooth the 'crochet' is united to a small 'combing-plate,' thus cutting off an 'accessory fossette.' In both teeth there is a distinct ridge projecting from the hinder side of the 'anterior collis' into the 'median valley,' which may be called an 'anti-crochet.' On the external surface of each tooth the anterior 'costa' is placed close to the antero-external angle of the crown, which is produced into a sharp process, the two ridges tending to the formation of a 'buttress,' which, however, is not so marked as in the true molars, the external surface being consequently less curved than in the latter. The teeth are about the size of the upper milk-molars of *R. sumatrensis*, and, therefore, proportionately somewhat smaller than the true molars. A detached specimen, otherwise indistinguishable from the last tooth, has the anterior 'collis' without an 'anti-crochet'; there is, therefore, the same variability in this respect in the milk-molars that we have seen to occur in the true molars. The specimen of a young maxilla of a rhinoceros represented in figure 3 of plate XIX of Messrs. Baker and Durand's memoir, containing the four milk-molars, probably belongs to the same species as the present specimen. The dimensions of the figured specimen will be found under the head of *R. palæindicus*. (p. 47.)

Comparisons between milk-molars.—From the above description it appears that the milk-molars provisionally assigned to *R. sivalensis* differ from the true molars by the occasional presence of a 'combing-plate,' and in the less development of the 'buttress' at the antero-external angle, and it is, therefore, incumbent on us to see whether analogous differences occur between the corresponding teeth of allied living species. There is unfortunately no specimen of the milk-molar dentition of *R. javanicus* available to me; but there are two skulls of *R. sumatrensis* (in which, as we have seen, the general form of the teeth is very like that of *R. javanicus*) in the Indian Museum, showing the deciduous dentition. In one of these specimens a 'combing-plate' occurs in the penultimate milk-molar, as in our specimen of the milk-molars of *R. sivalensis*, and none in the last. In the two last milk-molars of the living species, the 'buttress' at the antero-external angle is less produced than in the true molars. Hence the external wall of the two milk-molars, when the teeth are in the jaw, is nearly coincident with the long axis of the skull, while in the true molars the corresponding surface forms a large angle with the same axis. If the last milk-molar of *R. sivalensis* were fully produced, the outer surface of this and the anterior tooth would likewise be nearly

coincident with the long axis of the jaw. It is thus apparent that the differences existing between the teeth, which we have considered as the deciduous and permanent molars of the fossil Siwalik rhinoceros, are paralleled by corresponding differences between the homologous teeth of a living species with very similarly formed teeth, and there is accordingly a presumption of the correctness of the reference.

General remarks on the upper molar dentition of the Rhinocerotidæ.—It has been shown from the preceding comparisons that in, at all events, some of the species of rhinoceros, whose upper molars are formed on the plan of those of the living Javan and Sumatran species, the milk-molars present a less degree of specialisation than the true molars in regard to the relative development of the so-called 'buttress' at the antero-external angle. If, however, we turn to other species, like *R. indicus*, in which there is no distinct 'buttress' developed in the upper true molars, it will be found that in the milk-molars there occurs an approach to this 'buttress,' very like that which occurs in the milk-molars of the *R. sumatrensis* type.¹ Indeed, in place of the very wide difference occurring between the true molars of *R. indicus* and *R. sumatrensis*, there is only a comparatively very slight difference between their milk-molars. Now, at all events, the greater number of the old forms of the Rhinocerotidæ (*Acerotherium*, and I believe all the miocene species of *Rhinoceros*) possess teeth of the Sumatran type, which approaches the type of the teeth of other old perissodactyles, such as *Palæotherium*, *Anchitherium*, *Hyrachyus*, &c., and it is therefore pretty clear that this form of molar is the oldest. This, then, will explain the resemblance existing between the milk-molars of species whose true molars are formed, respectively, on the Sumatran and Indian types, it being not uncommon for ancestral characters to be retained in the deciduous series, which have long since disappeared in the permanent. It would be a necessary consequence of this hypothesis that species having teeth of the Indian type should be of comparatively recent origin, and such, indeed, appears to be the case. The earliest form seems to be the Siwalik *R. platyrhinus*, apparently only found in such parts of the Siwaliks as are without much doubt of pliocene age, and never occurring in the older Punjab and Sind beds; in the pleistocene we have *R. lichorhinus*, and at the present time *R. indicus* and *R. simus*. There also exist intermediate forms, which seem to have originated in the pliocene, and still live on; these have teeth without the distinct 'buttress' of the Sumatran type, but the 'crochet' and 'combing-plate' do not unite to cut off an accessory 'fossette,' as in the Indian type, and the latter may be absent; these intermediate forms are exemplified by the fossil *Rhinoceros etruscus*, *R. leptorhinus* (Owen) and the living African *R. bicornis*. If these conclusions be true, the Sumatran and Javan rhinoceroses must be considered as being the little altered descendants of a very old type, while *R. indicus* is a much more specialised form of later origin.

Mandibles of Siwalik rhinoceroses.—The authors of the "Fauna Antiqua

¹ This character is shown to a certain extent in the specimens of the milk-molar dentition of *R. indicus* figured by the author in the 'Jour. As. Soc., Bengal' (Vol. XLIX, pt. II, pl. VII), but more clearly in still younger specimens.

Sivalensis" have figured three distinct forms of the symphysis of the mandible of Siwalik rhinoceroses, which they have respectively referred to the three species named by them from the sub-Himalaya. In the first volume of this work I accepted these determinations, though a proviso was added in the preface that I was unaware on what grounds they rested. A subsequent reconsideration of the question has now convinced me that these determinations, in support of which there is no available evidence, are probably incorrect, and I shall accordingly proceed to show on what grounds they may be objected to. Before going further, however, it may be premised that from the remarkable similarity in the form of the lower molars of all species of rhinoceroses, it is a matter of extreme difficulty to specifically distinguish fragmentary fossil jaws not showing the symphysis, and accordingly only such specimens as exhibit this portion will be entirely relied upon for specific distinction. It appears indeed, to me, to be very problematical whether it would be possible to distinguish the lower molars of the living species, if removed from the characteristic parts of the mandible.

Of the specimens figured by Falconer and Cautley, the first is a jaw with the symphysis (pl. LXXIV, fig. 6), which seems to have carried no incisors, and in which the molar series extended far over the symphysis.¹ This specimen has been referred to *R. sivalensis*, and seems to be most nearly related to the mandibles of the pleistocene European and the living African rhinoceroses. The second form (pl. LXXIV, fig. 4) shows merely the symphysis, which carries a large pair of outer incisors, and apparently no median pair; the central part of this symphysis forms a uniform channel, sloping regularly from before backwards as in the Javan rhinoceros. This specimen has been referred to *R. paleindicus*. The third form is exemplified by two specimens, one of which (pl. LXXII, fig. 4) exhibits only the symphysis, while the other (pl. LXXV, fig. 10) shows the rami as well. In this form the symphysis carries a pair of large outer incisors, and another pair of very small inner ones; the central portion of this symphysis forms a channel which is convex in the middle of its course, as in *R. indicus*. This form has been referred to *R. platyrhinus*.

In the Indian Museum the only specimens (exclusive of the mandible of *Acrotherium perimense*) of the symphysis of the mandible of Siwalik rhinoceroses are two; one of these is merely a symphysis, and agrees with the form referred by Falconer and Cautley to *R. platyrhinus*: this specimen was obtained from the eastern Siwaliks in the neighbourhood of the river Jamma. The second specimen (pl. VI, fig. 3) agrees with the form referred by Falconer and Cautley to *R. paleindicus*, and was obtained by Mr. Theobald from the Siwaliks of the western Punjab.

With regard to the case of *R. sivalensis*, we have already shown that this is a unicorn species, showing great affinities in the form of its molars to the living *R. javanicus*. This being so, it is in the highest degree improbable that it was fur-

¹ From the description of this specimen in the index to the plates, the symphysis appears to be imperfect, and may have been produced into a spatulate form.

nished with a lower jaw totally unlike that of the latter species, and nearly resembling the jaws of the bicorn living African or pleistocene European species. Again, no known unicorn species, either recent or fossil, has a mandible unprovided with incisors, like the one referred by Falconer and Cautley to the unicorn *R. sivalensis*. Hence there is a very strong presumption indeed that the Siwalik lower jaw without incisors belonged to a bicorned species, while to *R. sivalensis* there belonged one of the two forms of tusked lower jaws referred by Falconer and Cautley to the other two Siwalik species. This inference is supported by the fact that in the Punjab none of the numerous mandibles of fossil rhinoceroses collected by Mr. Theobald belong to the form referred to *R. sivalensis*,¹ while nearly all the upper molars (except those of *Acerotherium*) belong to *R. sivalensis*, and none to *R. platyrhinus*. Falconer's determination would, therefore, drive us into the double dilemma of, firstly, referring to a species closely allied to the Javan rhinoceros, a form of jaw nearly resembling that of a bicorn species; and, secondly, of finding no lower jaws of a species in a district where its upper jaws and skulls are of comparatively common occurrence. I therefore conclude that Falconer and Cautley's determination of the lower jaw of *R. sivalensis* is probably incorrect.

From this it will be clear that one of the forms of mandible referred by Falconer and Cautley respectively to *R. palæindicus* and *R. platyrhinus* will probably belong to *R. sivalensis*. Now of these two, I find that the one referred to *R. palæindicus* approaches most nearly in general form to the mandible of *R. javanicus*, and that this one appears to be the most common in the Punjab where *R. sivalensis* is the prevailing species. It is true, indeed, that in the presence of median incisors the mandible referred by Falconer and Cautley to *R. platyrhinus* agrees more closely with the mandible of *R. javanicus*, but its general form is different, and it is by no means certain that small median incisors may not have been developed in the jaw I have provisionally assigned to *R. sivalensis*, and have been shed at an early period.

There now comes the question as to which of the two remaining lower jaws should be assigned respectively to *R. platyrhinus* and *R. palæindicus*. The former species, as has been already stated, is a bicorn form, and, as will be shown subsequently, has upper molars formed on the complex Indian type. Now, the only species of rhinoceroses known to me, which are bicorn, and furnished with permanent lower incisors, are *R. sumatrensis* (?=*R. lasiotis*) and *R. schleiermacheri*, and these have upper molars of the simple or Sumatran type. No bicorn species with teeth of the Indian type ever have permanent outer incisors,² though some species without incisors have molar teeth of the Sumatran or intermediate type; e.g., *R. bicornis*, *R. etruscus*, *R. leptorhinus* (Owen), *R. megarhinus*, *R. pachygnathus*, *R. tichorhinus*. Finally, as already said, there is no known instance of an

¹ Although these specimens, with one exception, do not show the symphysis, many of them show the whole of the premolar dentition, which, in the form referred by F. and C. to *R. sivalensis*, is placed directly on the symphysis; the specimens therefore indicate a form with a produced symphysis.

² According to M. Gaudry. (*loc. cit.* p. 52), *R. pachygnathus* and *R. leptorhinus* sometimes develop very minute inner incisors.

unicorn species having been unprovided with lower incisors. The balance of evidence therefore seems to be strongly in favour of the view that the form of Siwalik jaw without incisors should be referred to *R. platyrhinus*. This being so, the remaining jaw, with two pairs of incisors, must belong to *R. paleindicus*.

If the above determinations be correct, the specimens figured in the "Fauna Antiqua Sivalensis," must be redistributed as follows:—

- R. sivalensis*, plate 74, figs. 3, 4.
R. platyrhinus, " " fig. 6; pl. 75, fig. 6.
R. paleindicus, " 72, " 4; " " 10.

Mandible of R. sivalensis.—Assuming that the mandible, of which a figure, half the natural size, is given in plate VI, figure 3 of this volume, belongs to *Rhinoceros sivalensis*, we may proceed to the description of the specimen. It consists of the symphysis, and the left horizontal ramus of the mandible, showing the sockets of two incisors, and six complete molar teeth. Of the latter, the three last (m. 1. m. 2. m. 3) belong to the true molar, and the three earlier to the premolar series; the latter determination being made from the fact that the fourth tooth, counting from the left (m. 1), is more worn than the third tooth. The last true molar, though fully protruded from the alveolus, has not been touched by wear, so that the animal had only just attained its full development at the time of its death. The form of the whole jaw and teeth is so close to that of the corresponding parts of *R. javanicus* that it would be waste of words to give a detailed description; and it will, therefore, be sufficient to give the measurements of the two specimens. It may, however, be noticed that both specimens agree in the absence of the first premolar, which in the living form is very generally shed at an early period; this is in contrast to what occurs in *R. indicus* where the first premolar as frequently persists. Apart from the smaller size of the recent specimen, the only important difference that can be detected between the two is the absence of the alveoli of median incisors in the fossil. This no doubt is a very important point of difference, and it is somewhat difficult to account for the presence of these teeth in *R. javanicus*, if, as the other evidence seems to indicate, that species be the descendant of *R. sivalensis*. It is, however, quite possible, as already mentioned, that the latter species may have developed median incisors in the young state. The following table gives the dimensions of the jaws of the two species:—

	<i>R. sivalensis</i> .	<i>R. javanicus</i> .
Length of six molars	11·0	9·0
Length of first premolar	1·3	1·1
Height of " " (slightly worn)	1·1	1·0
Length of last true molar	2·1	1·73
Height of " "	1·56	1·22
Depth of jaw at first true molar	3·3	2·4
Width of narrowest pt. of symphysis	3·4	2·3
Long diameter of incisive alveolus	1·7	1·6
Shorter " " " "	1·1	0·9

The specimen of the symphysis figured in the "Fauna Antiqua Sivalensis," already referred to, is somewhat wider; this additional width seems in great part due to pressure; there are, however, analogous differences in the width of the symphysis of the living species.

Var. GAJENSIS, Nobis.

Specimens.—The next specimens for consideration are the hinder portion of a skull and the upper molar of a rhinoceros, obtained by Mr. Fedden in Sind from a group of rocks known as the Gáj beds (plate V, fig. 7; plate VII, fig. 1). The specimens in question are those on which rests the statement given in Mr. W. T. Blanford's "Geology of Western Sind," that *R. sivalensis* occurs in the Gáj beds, and is the only mammal found in them. The age of these beds is given in the same memoir as being probably miocene, with a possibility of being the upper part of that period. This fossil is accordingly in all probability from a lower horizon than any of the other mammals from Sind and the Siwaliks, and its specific determination is therefore a matter of very considerable interest. In the course of the following description, there will be pointed out certain peculiarities in which the remains from the Gáj beds differ from the corresponding remains of type specimens of *R. sivalensis*; but it will also be shown that in regard to the teeth there is a transition from the type Siwalik forms to the Gáj form, and I have, therefore, come to the conclusion that it will be best to consider, at all events provisionally, the Gáj fossil as a variety of *R. sivalensis*, for which I propose the name *gajensis*; at the same time indicating the possibility of its specific distinctness.

Skull.—The fragment of the skull unfortunately alone remaining consists of the hinder half only (pl. VII, fig. 1); this, however, is fairly perfect. This skull was found in company with two molars, one of which is figured in plate V, fig. 7, and was probably intact before it was extracted from its bed. The condition of the molars proves it to belong to an animal which had not attained its full dimensions. If the figure of the Gáj skull be compared with the corresponding part in the adult skulls of *R. sivalensis*, figured by Messrs. Baker and Durand,² by Falconer and Cautley,³ and in this volume, it will be seen that the supra-occipital region in the former is not produced into such a high angular peak as in those specimens, while the Gáj skull is also of considerably smaller dimensions. We have, however, seen reason to believe that the latter belongs to an immature individual, and it is, therefore, not in a condition to afford well-marked specific characters. Seeing that in the large living unicorn Indian rhinoceros there is a very considerable difference in the relative development of the supra-occipital region according to age,⁴ it is

¹ Mem. Geol. Surv. Ind., vol. XVII, p. 57.

² *Loc. cit.*, pl. V, fig. 3.

³ F. A. S.' pl. LXXIII, fig. 2a.

⁴ The non-development of the occipital region at an early age is well exhibited in a young skull of *R. indicus* figured by Dr. Gray ("Hand-list of Edentate, Thick-skinned, and Ruminant Mammals in the British Museum," pl. XIV). A good figure of an adult skull is given in De Blainville's "Osteographie."

not improbable that the Gáj skull is not fully developed in this respect. Again, the hinder portion of a small skull of a fossil rhinoceros from the Siwaliks, figured by Messrs. Baker and Durand,¹ agrees with the Gáj specimen in size and form. This skull was considered by those writers as belonging to a young individual of *R. sivalensis*; and if this determination be correct, it would show that the Gáj specimen is probably a young individual of the same. On the whole, it seems to me probable that the Gáj skull would never have developed such a high occipital region as the typical skulls of *R. sivalensis*; but, as we shall see below, there is such an intimate connection between the upper molars of the two forms that there would be great difficulty in making any well-defined specific distinctions, although, as already said, there is a possibility of the specific distinctness of one form. The Gáj skull exhibits very clearly the union of the post-glenoid and post-tympanic processes of the squamosal below the auditory meatus, a character which it shares, as far as is known, with all unicorn members of the family.

Upper true molar.—The upper molar drawn in figure 7 of plate V is the one nearly perfect specimen found with the Sind skull; it has unfortunately been broken on the free edge of the outer wall: when perfect it could only have been just touched by wear on this outer side, as the summits of the two 'colles' are still intact. The antero-posterior elongation of this tooth shows that it cannot belong to the premolar series; while the great development of the 'buttress' at the antero-external angle, and the curvature of the external, or dorsal surface, equally shows that it cannot be a milk-molar. The specimen must, therefore, be either the first or the second true molar. If the figure of this tooth be compared with that of the second upper true molar of *R. sivalensis* drawn in figure 2 of the same plate, it will be seen that, except as regards size, the two are exceedingly alike. The only differences that I can detect are that in the smaller tooth the groove on the posterior aspect of the 'anterior collis' is more pronounced, and the ensuing accessory spur considerably more developed than in the larger specimen; in the former there is also a distinct tubercle at the entrance to the 'median valley,' of which only a trace exists in the larger. Both agree in the form of the 'posterior valley.' In the teeth which are here provisionally considered as the milk-molars of *R. sivalensis*, there is the same conformation of the 'anterior collis' as in the Gáj specimen; consequently, since ancestral characters are often retained in the milk-molars, and if all the teeth belong to the same species, it would seem that in the Gáj race the form of the 'anterior collis' was the most complex; in the higher Manchhar form it was slightly less so, and in the highest Siwalik form it had become quite simple, its original complexity being retained only in the milk-molars.

Seeing thus that a transition can be traced from the Gáj molar, through the Manchhar, to the Siwalik specimen, there appear to be no valid grounds for assigning the first to a distinct species; as, however, the Gáj form is of considerably smaller size than either of the others, and as it presents certain points of

¹ *Loc. cit.*, pl. XVII, fig. 9.

difference from the type, I propose, as already said, that it should be known, at all events for the present, as *Rhinoceros sivalensis* var. *gajensis*. If the Gáj specimen were assigned to a distinct species, it would then be impossible to say whether the Manchhar upper molar should be referred to this new species with which it agrees in form, or to *R. sivalensis* with which it agrees in size.

The dimensions of the Gáj specimen are compared below with those of the first upper true molar of *R. javanicus*, from which it will be seen that the two indicate an animal of the same size :—

	Var. <i>gajensis</i> .	<i>R. javanicus</i> .
Length of anterior surface	26	21
" of outer "	205	186
" of posterior "	16	19
" of inner "	115	13

These measurements show that the same proportions pointed out above as distinguishing the larger teeth of *R. sivalensis* from those of *R. javanicus* prevail in the smaller Gáj variety of the former.

Distribution.—Remains of *Rhinoceros sivalensis* appear to have been obtained throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus; they have also been obtained from the lower Manchhar beds of Sind; while the variety, *gajensis*, occurs in the Gáj beds of the latter country. No remains of the species have hitherto been identified either from Burma or from Perim Island.

Conclusion.—In conclusion, it may be predicated of *R. sivalensis*, if all the remains described above are correctly assigned to it, that it is an unicorn species, the form of whose cranium is intermediate between that of *R. indicus* and *R. javanicus*; and that its molar dentition and mandible are exceedingly like those of the latter, and very different from those of the former species. It is, however, distinguished from the latter by the absence of median lower incisors. It was represented in the undoubted miocene by a smaller form presenting slight differences in the form of the molars from the typical pliocene form, and it is also possible there was a slight difference in the shape of the cranium of the earlier form, making an approach to the cranium of *R. javanicus*. The balance of evidence seems therefore to point to the intimate relationship existing between *R. sivalensis* and *R. javanicus*, and to the probability of the one being the ancestor of the other. It is, however, as already said, somewhat difficult to understand the absence of median incisors in the adult fossil form; and also in a lesser degree the greater apparent specialisation in the form of the skull.

Species 2.—*RHINOCEROS PALAINDICUS*, Falconer and Cautley.

Previous notices.—As far as can be discovered, no description or notice of this species was ever published by the authors of the "Fauna Antiqua Sivalensis," and the first appearance of the name seems to have been in that work, where several

skulls and other remains are figured. In that work there are figured two specimens of adult skulls (pl. LXXIII, fig. 1; pl. LXXIV, fig. 2), and one of an immature skull (pl. LXXIV, fig. 1), showing the milk-molar dentition.¹ In pl. LXXV, fig. 1 of the same work, there is figured the left upper molar dentition of a rhinoceros under the same specific name. An upper tooth of the molar series is represented in figure 4 of the same plate. Specimens of a mandible referred to this species are also figured, but, as has been said in the description of the last species, I have not accepted this identification. A short notice of this species has been given in the preceding volume of this work,² but beyond this no important or original notice has ever been published. I accordingly proceed to notice briefly the leading characters of the more important specimens figured in the "Fauna Antiqua Sivalensis" (the dentition of one of which will be noticed more fully), and to describe certain teeth from the collection of the Indian Museum apparently belonging to this species. It may be added that there are exceedingly few remains in the latter collection which can be referred to this species.

Cranium.—As far as can be judged from the figures given in the "Fauna Antiqua Sivalensis," the cranium of this species indicates that it carried one very large nasal horn, and that the superior border was highly curved, but to a less extent than in the preceding species; it was also distinguished by its greater width across the frontals. A cast of the young skull, already referred to, shows that the inferior squamosal processes were united below the auditory meatus. Measurements of the skulls figured in the "Fauna Antiqua Sivalensis" are given in the descriptions of the plates of that work,³ and this is about all that can be gathered from the materials at our disposal.

Upper molar dentition.—Among the crania figured in the "Fauna Antiqua Sivalensis," the specimen, of which the inferior aspect is represented in figure 2a of plate LXXIV, alone exhibits the greater part of the molar series in an intermediate condition of wear, and is accordingly the best adapted for studying the general characters of these teeth.⁴ This specimen shows that the true molars are readily distinguished from those of *R. sivalensis* by the absence of any distinct 'buttress' at the antero-external angle, and also by the consequently much greater flatness of the external surface of each tooth. The molar teeth of both species agree in the presence of a distinct 'crochet,' and in the absence of a 'combing-plate.' Very frequently, in the upper molars of *R. palæindicus*, the 'crochet' extends completely across the 'median valley' so as to cut off from this valley a separate pit, which, when the crown is worn down, appears as a distinct island or 'fossette,' frequently termed the 'accessory fossette.' In this respect the true molars of *R. palæindicus* in many cases differ from those of *R. sivalensis*, but this does not appear to be an

¹ In the description of this figure, the specimen is erroneously said to show the permanent dentition.

² Page 22 *et seq.*

³ "Pal. Mem." Vol. I.

⁴ It is impossible to avoid a certain repetition of the matter given in the first volume on this subject.

invariable point of distinction, as we have seen that a 'third fossette' is occasionally developed in some of the molars of the latter species, and it does not always appear to be present in those of the former.

The next specimen requiring notice is a detached upper molar, drawn of half the natural size in figure 4 of plate LXXV of the "*Fauna Antiqua Sivalensis*," and copied in figure 3 of plate IV of the first volume of this work. This tooth has a length of 2.5, and a breadth of 3.2 inches; it has hitherto been considered, following Falconer and Cautley, as a premolar, but its large size and proportionate length rather seem to indicate that it is a true molar, and it appears to agree precisely, both in form and size, with the right upper penultimate true molar of the skull drawn in plate LXXIV, figure 2a of the "*Fauna Antiqua Sivalensis*."

The last specimen of the upper molar dentition of this species figured in Falconer and Cautley's great work is contained in a detached specimen of the left maxilla showing the three true molars (pl. LXXV, fig. 1). In this specimen the teeth have the general characters of those of the other specimens, but, as far as can be judged from the figures, the external surface of the penultimate molar appears to be slightly more curved; this, however, does not appear to be a character of specific importance. The length of the penultimate tooth in that specimen is 2.4, and the width 3.2 inches.

Punjab specimen.—In plate VI, figure 1 of this volume are represented three associated upper molars of a fossil rhinoceros, which it seems probable should be referred to a small form of the present species. The figured teeth are contained in a portion of the left maxilla, collected by Mr. Theobald in the Siwaliks of the Punjab. That maxilla shows the broken base of a tooth to the right of the figured specimens, which is the remnant of the last true molar; the figured specimens will therefore be (counting from left to right) the last premolar and the first and second true molars. The whole of the three teeth are somewhat battered, but the premolar and the first true molar are fairly perfect; the second true molar has, however, lost its outer wall.

From the absence of any distinct 'buttress' at the antero-external angle of the first true molar, it is perfectly evident that these teeth can belong neither to *Acrotherium perimense* nor to *Rhinoceros sivalensis*. The want of a 'combing-plate' is equally convincing that they cannot belong to *R. platyrhinus*. Hence, unless they belong to a new species, they must be referred to *R. paleindicus*.

On comparing the two true molars of the specimen under consideration with the figures of the corresponding teeth of the specimen drawn in figure 1 of plate LXXV of the "*Fauna Antiqua Sivalensis*," the two appear to correspond very closely, except in the matter of size: it seems probable that in our specimen an 'accessory fossette' would be cut off from the 'median valley' in a more advanced state of wear. The premolar in our specimen has a wide ledge at the entrance of the 'median valley' forming a rudimentary 'cingulum.'

The dimensions of our specimen are as follows :—

Length of last premolar	. . . . .	1.4
Width of " "	. . . . .	1.9
Length of first true molar	. . . . .	1.5
Width of " "	. . . . .	2.05
Length of second "	. . . . .	1.9
Width of " "	. . . . .	(?)2.4

These measurements show that there is a very considerable difference in the size of the two specimens ; the dimensions of the second upper true molar of Falconer's specimen being 2.4 × 3.2 inches. The general resemblance between the teeth of the two specimens is, however, so close that I do not consider there is any evidence at present to warrant us in separating the two. We have already seen that the molars of Falconer's specimen seem to be slightly different from those of what may be called the type specimen, and in the Punjab specimen we have this slight difference in form accompanied by a difference in size. If all three specimens belong, as appears probably the case, to one species, we have another excellent instance of the variation to which a species may be subject.

British Museum skull of small race.—In the British Museum there is an imperfect cranium of a Siwalik rhinoceros, not figured in the "Fauna Antiqua Sivalensis," but labelled *R. palæindicus*, of which a cast is now in the Indian Museum. This cast shows that the cranium is imperfect superiorly, but the portion of the frontals remaining shows the great breadth characteristic of the skulls of *R. palæindicus*. The specimen exhibits the greater portion of the molar series of either side, but unfortunately every tooth has been split vertically and lost more or less of its outer half. The inner halves of the first and second true molars and the greater part of the two last premolars are fairly well exhibited. The true molars of this specimen, as far as can be judged from what remains of them, agree in general form with those last described, but are of slightly larger dimensions, thus breaking down the gap between the latter and Falconer's specimens. The premolars of this specimen, however, present a divergence in another direction. In place of having merely a small ledge at the entrance to the 'median valley,' as in the Punjab specimen, the last premolar has a distinct 'cingulum' along the whole of the inner side, and makes some approach to a tooth from Sind, represented in plate VI, figure 6 of the first volume of this work as a premolar of *Acerotherium perimense*. Taking into account, however, the resemblance of the skull in the British Museum to the skull of *R. palæindicus*, and of its true molars to those of the Punjab specimen, which we were unable to separate from that species, I cannot think the materials at present available would justify us in assigning the British Museum skull to a distinct species merely on account of the variation of one premolar. If this reference be correct, it shows how very uncertain must be any evidence, founded on a single premolar tooth, as to the species of its owner.

Last upper premolar.—In figure 2 of plate VII of this volume, there is represented one of two similar upper premolar teeth of a rhinoceros, obtained by Mr.

Theobald from the Siwaliks of the Punjab. The specimen figured is from the right side of the skull, and from its size is probably the last of the premolar series. With the exception of having been somewhat rolled on the outer surface, the specimen is perfect, and has been but slightly abraded by use. From a comparison of the figure with the figures of the upper premolars of *Acerotherium perimense* and *Rhinoceros sivalensis*, this tooth would seem not to belong to either of those species, the premolar of the former being characterised by its large 'cingulum,' and that of the latter by the greater development of the anterior 'costa,' and consequently greater flexure of the external surface. The last premolar of *R. platyrhinus* is distinguished by the presence of a distinct 'combing-plate.' It seems, therefore, not improbable that the tooth before us may be the last upper premolar of *R. palaeindicus*; but as these teeth seem so liable to variation, it is not possible to be certain on this point. The tooth is characterised by the sub-equal size of the two 'colles'; by the presence of a small and slightly bifurcate 'crochet'; and by the absence of any distinct 'combing-plate': the external surface has two equal-sized 'costæ,' which have been somewhat worn away by rolling. As regards form, the tooth appears to agree with the last upper premolar drawn in figure 1 of plate VI, but is of larger size, and must have belonged to an animal of the dimensions of Falconer's type specimens. If this tooth be a premolar of *R. palaeindicus*, it is quite evident that the detached tooth figured by Falconer as such, and already noticed, must be, as here considered, a true molar.

Upper milk-molars.—In figures 1, 1a, 1b, 1c of plate LXXIV of the "Fauna Antiqua Sivalensis" are given four views of a young skull of a Siwalik rhinoceros, referred by the authors of that work to *R. palaeindicus*: the general form of the skull seems to indicate that such determination is probably correct. In the post-humous descriptions of the plates, the specimen is said to show the permanent dentition, and this determination was originally accepted in the first volume of this work,¹ but was subsequently shown to be erroneous,² and that the four teeth present in the skull are really milk-molars. In figure 3 of plate VII of this volume, a view of the inner aspect of these teeth is given, taken from a cast of the skull, the original being in the British Museum. It is on the authority of Falconer's reference of this skull to *R. palaeindicus* that the milk-molars described above³ are assigned to *R. sivalensis*, since they differ considerably from those in the skull under consideration. It will, perhaps, be simpler to show in what respect the latter differ from the milk-molars referred to *R. sivalensis*, than to describe them in detail.

The two sets of teeth belong to the two opposite sides of the skull, and the set referred to *R. palaeindicus* contains the first milk-molar, which is wanting in the set referred to *R. sivalensis*. The second milk-molar (mm. 2) in the former is distinguished by having a very distinct median "costa" on the external surface, which does not occur in the corresponding tooth of *R. sivalensis*; the antero-external angle of the crown of the latter is more produced, and tends more towards

¹ Page 24.² Page 10.³ Pl. VI, fig. 2.

the inner side than in the former. The third and fourth milk-molars are very similar in general outline, those of *R. palæindicus* being mainly distinguished from those of *R. sivalensis* by their superior size. The 'colles' in the former are, however, of more regularly conical form than in the latter, and the third milk-molar of *R. palæindicus* does not show the small 'combing-plate' uniting with the 'crochet,' which occurs in *R. sivalensis*. The above mentioned differences, except in the case of the second milk-molars, are but slight, and if taken by themselves, it might be doubtful if they would afford grounds for specific distinction. The following measurements show the dimensions of the figured specimens of the milk-molars of the two species. :—

	<i>R. palæindicus.</i>	<i>R. sivalensis.</i>
Length of first milk-molar	1.1	...
Width of " "	0.89	...
Length of second "	1.65	1.6
Width of " "	1.5	1.3
Length of third "	1.9	1.65
Width of " "	1.85	1.6
Length of fourth "	2.2	1.87
Width of " "	1.9	1.74

Mandible.—Specimens of the form of mandible which seems most probably to belong to this species are represented in plates LXXII, fig. 4, and LXXV, fig. 10 of the "Fauna Antiqua Sivalensis," under the name of *R. platyrhinus*: the reasons for assigning this form of mandible to the present species have been already given under the head of *R. sivalensis*. A smaller-sized drawing of one of the specimens alluded to above is given in the "Palæontological Memoirs."¹ This form of mandible very closely resembles the mandible of *R. indicus*, both in its dentition and shape. The symphysis is thicker, and less channel-shaped in the middle than in *R. sivalensis* and *R. javanicus*. The first premolar seems to have been shed at an early date.

The dimensions of the specimen figured in plate LXXII of the 'Fauna Antiqua Sivalensis' are as follows, in inches :—

Length of fragment	13.5
Breadth of symphysis	5.7
Length of " inferiorly	7.0
Depth of jaw	4.7
Thickness of jaw	3.3
Length of four anterior molars	7.4
Interval between incisive alveolus and molar series	3.1
Width between posterior molars	4.0
" " anterior "	3.4

The specimen figured in plate LXXV of the "Fauna Antiqua Sivalensis" is referred to in the description of the plates of that work as follows :—"Lower jaw, right side, and symphysis, containing very large outer, and small inner incisor of

¹ Vol. I, pl. XIV, fig. 4.

both sides, second, third, and fourth premolars, and first two true molars of right side." Its dimensions are as follows:—

Length of second premolar	0.7
" of third "	1.4
" of fourth "	1.65
" of first true molar	1.46
" of second "	2.0
Width of second premolar	0.45
" of third "	0.85
" of fourth "	1.1
" of first true molar	1.05
" of second "	1.2
Width between second premolars	3.5
" " outer margins of outer incisors	3.65
Oblique width of outer incisor	1.5
" thickness "	0.7
Length of exerted portion	2.1

A very similar specimen of the symphysis, showing the alveoli of the median incisors, and the broken bases of the large external incisors, is in the collection of the Indian Museum. I am unacquainted with its history, though it is evidently from the Siwaliks.

Distribution.—Assuming that the specimens described above are all rightly referred to the present species, it would seem that its remains are found throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus; its remains are, however, of very rare occurrence in the Punjab. In the first volume of this work (plate VI, fig. 8) a single lower molar from Sind is referred to this species. Seeing, however, that no identifiable upper molars of *R. paleindicus* have been obtained from that district, and taking into consideration the extreme uncertainty of any specific determination based upon the evidence of lower molars, it may be doubted whether that identification will hold. No remains of the species, as far as I am aware, have been determined from Perim Island or Burma.

Species 3. RHINOCEROS PLATYRHINUS, Falconer and Cautley.

History.—The name of this species, like the last, seems to have first appeared in the "Fauna Antiqua Sivalensis," where some imperfect skulls and teeth are figured, together with a form of mandible referred to the same species. No description of the species was ever given by the authors of that work. A note on a cranium in the British Museum by Dr. Falconer, which from its manifest inaccuracies was never intended for publication, is quoted in the "Palæontologica Memoirs," and will be again referred to below.

The specimens figured in the "Fauna Antiqua Sivalensis" (pl. LXXII) are an anterior and a posterior portion of a skull (figs. 1, 2), and a penultimate and last upper true molar (figs. 6, 7). On plate LXXV of the same work specimens of each of the above teeth are figured, of half the natural size (figs. 11, 12). The restored

¹ Vol. I., p. 157.

figure of the penultimate upper molar figured in the latter plate has been copied in the first volume of this work,¹ where a short notice of the species is also given. In the preface to the same volume² it has been shown that the attempted identification of this species with *R. sumatrensis*³ by the late Professor Brandt is founded upon false premises.

Cranium.—Besides the imperfect specimens of the cranium of this species figured in the "Fauna Antiqua Sivalensis," reference is made by Dr. Falconer in the note already cited to a nearly complete cranium, stated to have been obtained by Colonel Baker, the collector of so many Siwalik fossils, and now in the British Museum. This skull appears never to have been fully described or figured in a scientific work,³ and I have accordingly given a profile view of it in this volume (pl. IX., fig. 2) in order to show its general form; this figure has been taken from a cast in the collection of the Indian Museum.

An examination of this cast shows that the skull is perfect, with the exception of the extremities of the premaxillæ, and that it belonged to a two-horned species, the rough surfaces for the attachment of the bases of two horns being most distinctly visible; the anterior horn must have been of very large size. The nasals are of great width and thickness, whence the specific name; this character is well shown in the specimen of which an upper view is given in figure 1 of plate LXXII of the "Fauna Antiqua Sivalensis." The supra-occipital region is produced into a high crest. The post-tympanic and the post-glenoidal processes of the squamosal are united below the external auditory meatus,—a character showing that the species has no direct affinity with *R. sumatrensis*. The premaxillæ are well developed, and perhaps carried a pair of incisors, though, if the mandible provisionally referred to this species really belongs to it, it may be doubted whether these teeth, if present, were persistent.⁴

In the following table some of the principal measurements of this skull are given in the first column, while in the second column are given some of the corresponding dimensions of the two imperfect specimens figured by Falconer and Cautley:—

Length from inferior border of foramen magnum to tip of premaxillæ (broken)	29.5
Greatest width across zygoma	14.7
Length of six molars	12.5
Interval between outer surfaces of penultimate molars	8.4
Height of occiput from inferior margin of foramen magnum	12.0 12.0
Width of " above	8.6 8.4
" of " below	13.3 13.2
Height of foramen magnum	2.5 2.5
Width of " "	2.1 2.0
Interval between external angles of occipital condyles	6.0 5.3
Extreme length of cranium, following curves of upper surface	33.0
Greatest width at orbits	10.4 13.6
Width of nasals	6.0

Pl. IV., fig. 4. ² P. xi.

³ This skull is figured on a small scale on page 28 of the "Ward series of casts of Fossils." Rochester, N. Y. 1866.

It is stated in the above mentioned note of Dr. Falconer that this species certainly had an upper incisor; no trace of such, however, is seen in the skull on which the note is based.

These measurements show that the three skulls have almost precisely the same dimensions; indeed, almost the only exception occurs in the occipital condyles, which appear smaller in one of Falconer's specimens; this, however, is very probably due to their having been injured.

Upper molars.—In plate VIII of this volume there is figured the upper molar dentition of the right side of the skull described above, drawn of two-thirds the natural size, from the cast in the Indian Museum. These teeth have already been shortly noticed on page 30 of the first volume of this work; but as they are now figured for the first time, they may be described somewhat more fully. In reference to these teeth the note of Falconer's, already referred to, published in the "Palæontological Memoirs" must be cited; it is as follows:—"The molars are in fine condition, six on either side. The last true molar is only just touched by wear. The last true molar is exactly like [that of] *R. hemitæchus*, in having a posterior basal funnel-shaped pit; while the penultimate and ante-penultimate true molars, and the penultimate and ante-penultimate premolars,¹ have each three distinct fossettes as in *Rhinoceros tichorhinus*. The vertical ridges of the outer side are very well pronounced in three valleys (*sic*)."

This note gives a fair general idea of the characters of the teeth in question. The three anterior teeth (pm. 2, pm. 3, pm. 4) are shown to be premolars, from the fact of the last of them being less worn than the first true molar (m. 1). The first premolar (or ? milk-molar) has probably been broken off subsequently to the death of the animal, as its 'fangs' are still visible. The teeth belong to that form we have agreed to call the 'Indian type.' The 'dorsal' surface of each tooth is approximately straight, and carries two very distinct vertical ridges or 'costæ.' In the first true molar the hind-most of these ridges is much smaller than the other; in the second molar this 'costa' has nearly, and in the last quite, disappeared; there is no trace of a 'buttress' at the antero-external angle of the crown. The 'crochet' and the 'comb-ing-plate' are united, and enclose between them an 'accessory fossette,' as is well exhibited in the first and second true molars (m 1. m 2). The last true molar of the left side shows at its posterior angle a minute in-folding of the enamel, representing the 'posterior valley' of the earlier teeth. A similar fold has already been shown to exist in the corresponding tooth of *R. sivalensis* and *R. javanicus*, and is, therefore, not, as one might be led to suppose from Dr. Falconer's note, peculiar to the present species and *R. leptorhinus* (*hemitæchus*).

The dimensions of the molars of this specimen are as follows:—

Length of second premolar	. . . . .	1.75
Width of " "	. . . . .	2.1
Length of third " "	. . . . .	2.05
Width of " "	. . . . .	2.4
Length of fourth " "	. . . . .	2.1
Width of " "	. . . . .	2.5
Length of first true molar	. . . . .	2.4

¹ In the "Palæontological Memoirs" the word "milk-molars" occurs here; this is clearly a slip of the pen in Dr. Falconer's note-book, and has accordingly been altered.

Width of first true molar	3.1
Length of second „	2.7
Width of „ „	3.3
Length of third „	2.75
Width of „ „	2.9 (F)

The detached specimen of the last upper true molar figured, of half the natural size, in plate LXXII, fig. 7, of the "Fauna Antiqua Sivalensis," I have compared, by means of a cast, with the corresponding tooth in the set before us, and I find that the two are identical in form. The detached specimen seems rather the larger of the two, but this is, at all events partly, due to the other not being fully protruded. The length of the detached specimen is 3.2, its width 3.1,¹ and its height 3.1 inches. This tooth shows very clearly the pit at the posterior angle. The tooth drawn in figures 12 and 12a of plate LXXV of the "Fauna Antiqua Sivalensis" seems to be another view of the same specimen.

A specimen of the first or second upper true molar, represented in figure 6 of plate LXXII of the same work, is stated in the description of the plate to have a length of 2.3 and a width of 3.4 inches. The dimensions taken from the figure, however, would give a length of 3.6 and a width of about 3 inches. Similarly, the dimensions of the specimen drawn in figure 11 of plate LXXV of the same work would have a length of 4 and a width of 3 inches; this specimen is, however, restored, and the length is probably excessive. These two molars, if drawn to correct scale, would indicate that they belonged to a larger skull than the one above described. In general characters these teeth seem to agree with the true molars figured here; they, however, possess a more complex 'crochet,' which bifurcates at its extremity.

Comparisons.—Having now shortly noticed the main characters of the skull and upper molars of *R. platyrhinus*, we may endeavour to see with what other species of the genus it presents affinities. In this respect we shall of course have to deal only with two-horned species.

With *R. sumatrensis*, the skull of *R. platyrhinus* presents no affinities, since the teeth of the two are constructed on totally distinct plans, and, as we have already seen, differ in regard to the relations of their inferior squamosal processes. The miocene *R. schleiermacheri* is likewise distinguished by the form of its teeth, which are constructed after the Sumatran type.

Among the European bicorn species of the pliocene and pleistocene, in *R. etruscus*, *R. leptorhinus* (Owen), and *R. megarhinus*, the upper true molars, which seem to conform to what we have called the 'intermediate type,' do not usually present an 'accessory fossette' on the worn crown, the 'combing-plate' being either absent or, if present, not reaching the 'crochet.' *R. tichorhinus* agrees the most nearly of all these European species with *R. platyrhinus*, having two horns, and upper molars constructed on the same general plan, with an 'accessory fossette.' The cranium of the European form is, however, broadly distinguished by the presence

¹ This dimension is given by Falconer as 2.8 inches.

of the nasal 'cloison,' of which there is no trace in the Indian fossil. The true molars of the two forms, though presenting great general resemblances, as far as I can judge, are distinguished by the fact that in the Indian species the entrance to the 'median valley' is open nearly to its base, whereas in the European it is blocked by a 'pass,' joining the bases of the two 'colles', sometimes for a distance of nearly half their height.

The living African rhinoceroses are distinguished by the abortion of the premaxillæ, from the present species, in which they are well developed. In the true molars of *R. bicornis* an 'accessory fossette' is not normally present. In *R. simus*, the peculiar blunted form of the nasals is a very distinguishing character. From *R. pachygnathus* of the European miocene, the present species is distinguished by the characters of the upper molars, those of the former not presenting an 'accessory fossette':¹ the upper molars of the Indian *R. deccanensis* of the pleistocene, probably also a bicorn form, present no close resemblance to those of the present species.

Upper milk-molars.—In figure 4 of plate VII there are represented two small upper molars of a rhinoceros from the left side of the jaw. The figure is taken from the cast of two teeth in the British Museum, where they are, I believe, labelled as milk-molars of *R. palæindicus*: they were obtained from the Siwaliks. From the small size of these teeth, together with their general form, there can be no doubt but that they belong to the milk-molar series; while from the considerations advanced in treating of the milk-molars assigned above to *R. sivalensis*, they must be respectively the second and third of that series.

The anterior tooth (mm. 2) is of somewhat irregular form, as is generally the case with the early milk-molars, and carries a bold 'costa' opposite the entrance to the 'median valley.' The hinder tooth (mm. 3) is of the regular form, and carries a distinct 'costa' opposite each of the 'colles', the anterior being the most developed. Both teeth exhibit clearly the presence of a large 'crochet' and a 'combing-plate, which unite to form an 'accessory fossette.' There are also rudiments of additional 'combing-plates.' A 'cingulum' is present on the anterior surface of each tooth. The entrance to the 'median valley' is perfectly free and open, without any trace of a 'pass.'

The large size of the 'combing-plate' and its distinct union with the 'crochet' to cut off a very large 'accessory fossette', in both these teeth, sufficiently distinguishes them from the milk-molars referred above, respectively, to *R. sivalensis* (pl. VI, fig. 2), *R. palæindicus* (pl. VII, fig. 3), and *Acerotherium perimense* (pl. III, fig. 2). There is, therefore, every presumption that they should be referred to *R. platyrhinus*, a presumption rendered almost a certainty by the agreement in the general characters of these teeth with those of the true molars of that species.

This provisional reference has a bearing on a tooth described and figured in the previous volume of this series (pl. VI, fig. 10). In describing that specimen

¹ See "Animaux Fossiles et Géologie de l'Attique," plate XXVII, fig. 2.

(p. 46), it was considered that it belonged to the premolar series, and it was hence concluded that it could not belong to *R. platyrhinus*, though it was shown that it presented the general characters of the true molars of that species. In the subsequently issued preface to the first volume (p. xii), it was stated that this tooth was probably an anterior milk-molar of *R. platyrhinus*. A comparison of the figure with that of the teeth considered to be the milk-molars of that species will show that the single tooth agrees so closely with the second milk-molar that the two are doubtless homologous. The detached tooth is somewhat more produced antero-posteriorly, but this cannot be considered as a character of more than individual value. Besides the last specimen, there is another specimen of a right upper milk-molar of a Siwalik rhinoceros in the Indian Museum, numbered S. 854 in Dr. Falconer's "Catalogue of the Fossil Vertebrata of the Asiatic Society of Bengal." This tooth agrees precisely with the third upper milk-molar (mm. 3) referred above to *R. platyrhinus*, and must be the corresponding tooth of the opposite side.

The dimensions of the four above-described milk-molars are as follows; the dimensions of the casts of the British Museum specimens are given in the first column and those of the Indian Museum specimens in the second :—

Length of second milk-molar	1.7	1.6
Width of " " "	1.4	1.4
Length of third " " "	2.0	1.94
Width of " " "	2.0	1.91

A comparison of these milk-molars with the corresponding teeth of the European *R. tichorhinus* shows that the latter are distinguished by the presence of a distinct 'pass' at the entrance to the 'median valley.' In this respect, therefore, the milk-molars of the two species agree with the true molars.

Mandible.—The reasons for the provisional assignation of the mandible represented in figure 6 of plate LXXIV of the "Fauna Antiqua Sivalensis" under the name of *R. sivalensis* to the present species have already been given at length when treating of that species.

The specimen as figured shows that the premolars extend up to the extremity of the part of the symphysis remaining, thereby giving the jaw very much the appearance of the mandibles of the African rhinoceroses. From the description of the plate, however, it may be inferred that the extremity of the symphysis has been broken off. Now, since we have already seen that the premaxillæ of *R. platyrhinus* (in common with other Siwalik rhinoceroses) are well developed, I infer that the extremity of the mandible, when complete, was produced into a 'spatula' beyond the premolars. Its original form was probably very like that of the mandible of the extinct European *R. etruscus*,¹ in which the anterior premolars are situated above the hinder part of the symphysis, and still have the spatulate portion in advance of them.

The specimen under consideration has lost the hinder portion of each ramus,

¹ "Pal. Mem.," Vol. II, pl. XXVII, fig. 3.

and shows the three last premolars and the first and second true molars. Its dimensions are as follows as given by Falconer :—

Length of fragment	9.4
" of existing portion of symphysis	3.1
" of five molars	7.0
Width between 2nd true molars	2.7
" " premolars	2.0
Greatest depth of ramus	3.6
Thickness of ramus	2.0
Length of second premolar	1.2
Width of " "	0.75
Length of third "	1.2
Width of " "	1.0
Length of fourth "	1.7
Width of " "	1.15
Length of first true molar	1.6
Width of " "	1.3
Length of second "	1.9
Width of " "	1.36

These dimensions show that this mandible must have belonged to a smaller individual than the cranium described above: the one may have belonged to a female and the other to a male.

Young mandible.—In figure 5 of plate XVI of the memoir of Messrs. Baker and Durand, already cited, there is engraved the symphysis of the mandible of a rhinoceros, which is stated in the text to contain four molars, the last of which is unworn; as there are no earlier teeth, it is presumed that they belong to the milk-molar series. These teeth extend nearly up to the present end of the symphysis, the tip of which is stated to have been broken away. Unfortunately the posterior extremity of the symphysis is not shown in the figure, it being probably not cleared from matrix. The extension of the early part of the molar series, far on to the symphysis, seems to show that this jaw is of the same type as the one described above, and that when complete it was produced into an edentulous spatulate extremity. The dimensions of the specimen are not given.

The last milk-molar in this specimen, as noticed by its describers, is remarkable for bearing an isolated pillar in its posterior crescent. In this character it agrees with a lower molar of a rhinoceros figured in plate VI, figure 7 of the first volume of this work. That specimen belongs to a fragment of the right ramus of the mandible containing a similar but larger tooth. The figured tooth was considered in the first volume to be a true molar, but from its agreement with Messrs. Baker and Durand's specimen it would seem to be a milk-molar, as was considered to be the case by Dr. Falconer. The symphysis of this jaw is not shown, but it does not seem likely that it could have extended backwards as far as the figured tooth. In figure 5 of the same plate of Messrs. Baker and Durand's memoir, there is figured the fragment of the left ramus of a young mandible, stated to contain the third and fourth milk-molars, each of which presents a similarly isolated pillar in the posterior crescent. This specimen, however, seems to show pretty clearly that these

teeth were placed behind the symphysis, and accordingly this jaw would seem to belong to a distinct species from the other specimen with similar teeth figured by the same writers. Hence it would appear that the presence of the isolated pillar in the posterior crescent may appear in the lower milk-molars of more than one species, and that it cannot be regarded as of specific value. The first specimen figured by Messrs. Baker and Durand probably belongs to *R. platyrhinus*, the second and also the specimen figured in the first volume of this series cannot be specifically determined.

Sub-generic position of the species.—If all the remains, provisionally referred above to *Rhinoceros platyrhinus* be correctly determined, it would seem probable that that species belonged, like the four bicorn species of the European pliocene and pleistocene, to a modification of the group, sub-genus, or genus *Atelodus*, the typical members of which are the living African rhinoceroses, and the extinct *R. pachygnathus* of the Pikermi beds, and to which, in all probability, the Indian pleistocene species, *R. deccanensis*, should be referred.

If, on the other hand, Falconer's reference of a mandible, furnished with two pairs of incisors, to this species be correct, it will then belong to the group *Ceratorhinus*. Very strong reasons have, however, been already advanced against this reference.

Distribution.—As far as I am aware, remains of this species have only been found in the typical Siwaliks near the Ganges and Jamna.

UNDETERMINED REMAINS.

Limb-bones.—A large series of limb-bones of rhinoceroses from the Siwaliks is contained in the collection of the Indian Museum, but as I have at present been unable to refer them to their respective species, it would be useless to notice them further on this occasion. It may, however, be observed that even if we had not the evidence of the teeth and skulls described above, the existence of at least three Siwalik species of rhinoceros could have been predicated from the evidence of certain of the limb-bones, such as the astragalus.

Lower molars.—The extreme difficulty, or even impossibility, of generally distinguishing species of fossil rhinoceros from the evidence of detached lower molars has already been commented upon. In certain instances, however, there are peculiarities which serve to distinguish these teeth from the ordinary forms.

Such an instance is afforded by the lower molar from the Siwaliks of Kúshalghar in the Punjab, represented in figure 3 of plate VI of the preceding volume. This tooth is characterised by a distinct wall on the inner side of the 'posterior valley.' No such wall is found in the lower molars of any of the species described above, and unless this character be an abnormality, it seems probable, as stated in the first volume, that this tooth must belong to a fifth species of Siwalik rhinoceros. It must, however, be observed that in a mandible of *R. javanicus*, in my own possession, the second premolar on the left side only shows a wall in the anterior

crescent, very similar to that occurring in the posterior crescent of the figured specimen.

With the exception of the latter tooth, it has now been shown that none of the described teeth of Siwalik rhinoceroses known to me can be said with any degree of certainty to belong to any but the named species.

Tibetan species.—In the "Fauna Antiqua Sivalensis"¹ are figured certain limb-bones of a fossil rhinoceros from the Húndes plain in Tibet. In Royle's "Illustrations of the Botany, &c., of the Himalaya Mountains,"² there is also figured a specifically undeterminable fragment of an upper molar of the same genus. It was formerly considered that these Húndes deposits were the equivalents of the Siwaliks, but in a recent paper by myself³ it has been shown that they are probably of pleistocene age. The fossil rhinoceros obtained from them does not therefore come within the scope of the present memoir. It may, however, be added that it would be a matter of the highest interest to obtain specimens of the skull or complete upper molars of the Húndes rhinoceros, in order to see whether it was most nearly related to the Siwalik or the living species.

REMARKS ON THE PEDIGREE OF THE INDIAN SPECIES OF RHINOCEROS.

In his admirable work, entitled "Les Enchaînements du Monde Animal," to which reference has so frequently been made in the preceding pages, Professor Albert Gaudry has devoted a chapter to the pedigree of the *Rhinocerotidae*, both generically and specifically. It has there been shown that *Acerotherium* connects the more highly specialised genus *Rhinoceros* with the older generalised forms of *Perissodactyla*, and that traces of this connection are retained in the former genus by the small development of the nasals, and by the presence of the 'cingulum' on the lower molars. In the preceding pages of this volume it has likewise been shown that the molars of the large Indian unicorn rhinoceros, and those of similar pattern, belong to the most specialised and modern type, while those of *Acerotherium* belong to the simplest type found in the family.

With regard to the evolution of the species, Professor Gaudry has commented upon the resemblance of *Rhinoceros pachygnathus* of the Pikermi beds, to the living African forms, and both that writer and Professor Flower⁴ have noticed the points of connection between *R. schleiermacheri* of the European miocene and the living *R. sumatrensis* (and (?) *lasiotis*). In the following paragraphs a few remarks, more especially bearing on the evolution of the Indian forms, will be added.

With regard to the unicorn species, very strong evidence has been adduced to show that *R. javanicus* is probably the descendant of *R. sivalensis*. In the case of *R. indicus*, it has been shown in the preface to the first volume that teeth obtained from the pleistocene deposits of the Narbada valley are practically indistinguishable from those of the living form, and the two have accord-

¹ Pl. LXXVI, figs. 9, 10.

² R. G. S. I., Vol. XIV, p. 178.

³ Pl. III, fig. 3, copied in fig. 9, of above-quoted plate in 'F. A. S.'

⁴ *Loc. cit.*, p. 456.

ingly been provisionally identified; it is, however, very much to be desired that the cranium of the Narbada form may some day be obtained in order to see whether there may be any difference between it and the living form. Of the rhinoceroses of the pliocene (Siwalik), no form can be decidedly fixed upon as the direct ancestor of *R. indicus*.¹ The Siwalik *R. palaeindicus*, however, if all the remains assigned to it above be correctly referred, agrees with the large living Indian species in being unicorn, and also in the form of the mandible and the number of its lower incisors. In the form of its upper true molars this species, moreover, makes an approach to the living species, since its teeth lack the distinct 'buttress' at the antero-external angle, so characteristic of the teeth of the Sumatran type. There is no 'combing-plate' in the true-molars of *R. palaeindicus*, the presence of which is such a characteristic feature in those of *R. indicus*: the want of this process in the earlier form might, however, be readily explained by evolution, as it never occurs in molars of the Sumatran type, to which those of all the species of *Acerotherium* belong. In the above respects the upper molars of *R. palaeindicus* are exactly intermediate in character between those of the Sumatran or Acerotherian type, and those of *R. indicus*, and it has accordingly appeared to me not improbable that *R. palaeindicus* may belong to the *stirps* from which the living species has been derived, though the line of descent may not have been directly through the former.

We now come to the consideration of the living bicorn Indian species *R. sumatrensis*, which with *R. lasiotis*² is the modern representative of the group *Ceratorhinus*. Professor Flower has shown in what respects the European miocene *R. scleiermacheri*, which belongs to the same group, resembles and differs from the living species. The latter is distinguished from the former by the non-union of the post-glenoid and post-tympanic processes of the squamosal below the meatus auditorius; it is also further distinguished by the presence of one, in place of two pairs, of incisors in both upper and lower jaws. As is observed by Professor Flower,³ the difference in the number of the teeth of the two forms is in accordance with the hypothesis of the evolution of the one from the other, being a progress from the general to the special. The relations of the squamosal processes point, however, exactly in the opposite direction, being from the special to the general, and it is accordingly very hard to see how the miocene can be the direct ancestor of the recent species. The general form of the skulls and mandibles of the two forms, as is noticed by Professor Gaudry,⁴ is, however, so very similar that it seems probable they are closely related. Both species may have been derived from a common stock, from which *R. scleiermacheri* branched off at an earlier period, the direct progenitor of *R. sumatrensis* being, according to this view, still unknown.

¹ On page 55 of the first volume of this work it was suggested, perhaps somewhat hastily, that *R. indicus* was descended from *R. platyrhinus*: the re-determination of the mandible of the latter, apart from the horn-question shows that this idea cannot be entertained.

² *R. lasiotis*, if it be more than a variety of *R. sumatrensis*, is not distinguished, as far as is known, by any peculiar dental or osteological characters.

³ *Loc. cit.*, page 456.

⁴ *Loc. cit.*, pp. 44-45.

With regard to *R. platyrhinus*, there is some difficulty in deciding to which group of the genus it should be referred.¹ If the lower jaw assigned to it in this work really belong to it, it would appear, as said above, that the species must be a modified form of the *Atelodus* group, to which belong the living African rhinoceroses, the Pikermi *R. pachygnathus*, and, as modified forms, the four newer pliocene and pliestocene British bicorn species. The Indian form had not the aborted premaxillæ of the Pikermi and African species, and is further distinguished from the two latter by the union of the inferior squamosal processes; it is, therefore, difficult to imagine this species to have been a direct ancestor of either of the living African forms. In the form of its upper molars *R. platyrhinus* agrees very closely with *R. sinus*. Similarly the upper molars of *R. pachygnathus* approach those of the African *R. bicornis*; but the same difference in the relations of the inferior squamosal processes occurs in these species. In both instances, however, the general similarity of the form of the skulls would seem to indicate some kind of relationship between these four species as respectively coupled; the precise nature of this relationship, however, cannot at present be more closely pointed out.

The pleistocene Indian *R. deccanensis*, judging from the shape of its mandible, as already said, would also seem to be a bicorn form, belonging to a modification of *Atelodus*. From the shape of its mandible, the species shows resemblance to the British fossil forms of the group; but the structure of its upper molars indicates affinity with older forms of the family.

Nothing can be predicated as to the subsequent history of the Indian form known as *Acerotherium perimense*.

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INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SUPPLEMENT TO SIWALIK AND NARBADA PROBOSCIDIA.

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

DINOTHERIUM INDICUM, Falconer.

INTRODUCTORY.—Since the publication of the notice of the remains of this species in the Indian Museum in the first volume of this work,¹ two additional specimens have been temporarily acquired by the museum, which are of such importance as to merit a short notice here, although it is unnecessary to give figures of them. The specimens, which were obtained from the Siwaliks of Perim Island,—the source of the specimens on which the species was founded—belong to the Bombay Branch of the Royal Asiatic Society, to the courtesy of the Council of which body the author is indebted for the opportunity of noticing them here: they have been already briefly alluded to in the 'Records' of our Survey.² The specimens comprise a portion of a maxilla, and of a mandible, and will be noticed separately.

Fragment of maxilla.—The fragment of a maxilla consists of the hinder portion of the left side, containing the second and third true molars, and the base of the first. The teeth are of large size and in a somewhat battered condition: each tooth bears two ridges, and large fore-and-aft talons. The dimensions of the teeth are as follows:—

Length of 2nd molar	.	.	.	.	.	.	.	.	3.95
Width of " "	.	.	.	.	.	.	.	.	3.8
Length of 3rd "	.	.	.	.	.	.	.	.	3.6
Width of " "	.	.	.	.	.	.	.	.	3.7

These dimensions indicate an animal fully as large as the European *D. giganteum*. The size of the teeth in the Perim specimen agrees with that of the fragmentary specimen represented in plate XXXI, figure 1, of the first volume of this work.

Mandible.—The fragment of the mandible consists of the middle portion of the right ramus, showing the first and second true molars,³ and the base of the last premolar.

¹ Page 192. ² Vol. XIV, p. 155.

³ In the already quoted note in the 'Records,' this specimen is erroneously stated to show the two last, in place of the two first, true molars.

The first true molar, as usual, carries three ridges, and is oblong in form; the second carries two ridges, and approximates more nearly to a square. In the following table the dimensions of this mandible are compared with the corresponding dimensions of a cast of the Eppelsheim skull of *D. giganteum*:—

	Indian.	European.
Depth of mandible at last premolar	8·0	8·0
" " second true molar	7·5	6·3
Width of " " " " " " " "	7·1	5·5
Interval between base of molars and foramen of mandibular nerve .	4·1	2·9
Length of 1st true molar	3·9	3·5
Width of " " " " " " " "	2·7	2·65
Length of 2nd " " " " " " " "	3·9	3·55
Width of " " " " " " " "	3·4	3·3

From these measurements it will be seen that the Perim jaw is altogether of larger dimensions than the European, and further, that in the former the proportionate increase of depth near the symphysis is greater than in the latter. In all respects the jaw agrees precisely with the fragment of the left side described by Dr. Falconer from Perim Island,¹ and the new jaw, therefore, undoubtedly belongs to the same species. The whole jaw is deeper and thicker than in *D. giganteum*, and thereby, as was pointed out by Dr Faconer, "approaches very closely the massive and turbid form seen in the typical mastodons."

With regard to the molars, it will be seen that in the Indian species the true molars are longer in proportion to their breadth than in the European species. The tooth from Sind, figured and described in the first volume,² agrees precisely, both in dimensions and form, with the first true molar of the Perim specimen. Hence we may infer, firstly, that the reference of the Sind tooth to *D. indicum* was correct; and, secondly, that the proportion of the antero-posterior and transverse axes of the first true molar is constant, and affords an important distinction between the Indian and European species.

Finally, the examination of this jaw from Perim Island strongly confirms the conclusion arrived at in the first volume as to the existence of three Indian species of *Dinotherium*, distinct from their European congeners.

MASTODON PANDIONIS, Falconer.

Mandibles.—Three specimens of mandibles of mastodons have come under my notice since the publication of the first volume, two of which certainly, and the third probably, may be referred to this species.

Perim Island specimen.—The first specimen is another from the Bombay Asiatic Society's collection, and has been already alluded to in the 'Records.'³ The fragment consists of the greater portion of the right ramus of the mandible, containing two molars. They each contain three ridges and a hind talon, and from their

¹ 'Pal. Mem.,' Vol. 1, p. 404. ² Pl. XXXI, fig. 2, p. 194. ³ *Loc. cit.*

size seem to be the first and second true molars.¹ The teeth agree in general characters precisely with those figured in the first volume.

The dimensions are as follows :—

Length of 1st true molar	.	.	.	.	.	.	4.3
Width of " "	.	.	.	.	.	.	2.4
Length of 2nd "	.	.	.	.	.	.	5.0
Width of " "	.	.	.	.	.	.	2.6

The first true molar agrees almost exactly in size with the specimen of the homologous tooth described on page 219 of the first volume.

Punjab specimen.—Another very similar specimen is in the Lahore Museum, from the Siwaliks of the Punjab.

British Museum specimen.—Mr. William Davies, of the Palæontological Department of the British Museum, recently showed me a small fragment of the distal extremity of the right ramus of a mandible of a young mastodon, lately discovered among some Siwalik fossils, which is worthy of a short notice here. The fragment (of which the Indian Museum has acquired a cast) is some five inches in length, and two in depth; it is elongated and laterally compressed. It shows the alveoli of three teeth of the milk-molar series. The first of these alveoli is of such small dimensions ($\frac{2}{3}$ ths of an inch in diameter), that I am strongly inclined to think that it contained the pre-antepenultimate milk-molar, a tooth only very occasionally developed in the Proboscidea.

The distal extremity of the specimen has been ground and polished, and exhibits the transverse section of a small and laterally compressed milk-tusk.

From the elongated and laterally compressed form of this jaw, and from the presence of the tusk, I agree with Mr. Davies in thinking that it should probably be referred to *M. pandonis*. It would be a matter of much interest to discover whether four milk-molars were normally developed in this species, since it is among the simple-toothed trilophodons that we should expect to find the whole four present.

OCCURRENCE OF SIWALIK AND NARBADA PROBOSCIDIA IN JAPAN.

INTRODUCTORY.—Since the publication of the concluding fasciculus of the first volume, a memoir by Dr. E. Naumann, on the occurrence of fossil elephants in Japan, has appeared in the German "Paläontographica."² In that memoir there are described and figured remains of two species of Indian stegodons, and of *Elephas namadicus*, all of which were found in Japan.

Stegodon cliffi.—Of the stegodons, the first species described is *Stegodon cliffi*, of which a last lower molar is figured (pl. I). This specimen was obtained on the coast of a small island called Shozushima, situated in the inland sea, lying

¹ In the above-quoted note in the 'Records' I classed these teeth as 2nd and 3rd true molars, having in a hasty examination mistaken the talon of the last tooth for a true ridge: hence I thought the specimens abnormally small. The note having been printed in my absence contains the absurd sentence "the penultimate and last two molars;" it should have been "the penultimate and last true molars."

² "Über japanische Elephanten der Vorzeit," "Paläontographica," 1881.

to the north of the province of Sikok (Shikok). The fossil is described as being highly mineralised, and covered with sea-shells, having probably been washed out of sub-marine strata. This suggests a close analogy with the deposits of Perim Island. The figure leaves no doubt that the specimen is correctly referred to *S. clifti*.

Stegodon insignis, or bombifrons.—The remains of the next species of the genus were obtained in the province of Omi (in the southern third of the large island), and are referred by the author of the memoir to *S. insignis*. From the lowness of the ridge-formula of the teeth, as well as from the form of the ridges, I am myself rather inclined to think that these teeth should be referred to *S. bombifrons*: this, however, is a matter of minor moment.

Elephas namadicus.—The remains of *Elephas namadicus* seem to have been obtained with those of the last species.

Elephas primigenius.—In addition to the above there is described (p. 31) an upper molar of *E. primigenius*. Unfortunately the exact history of this tooth is unknown, but Dr. Naumann thinks there is little doubt that it is of Japanese origin.

Inferences from the above.—The discovery of these three species of fossil Indian elephants in Japan is of the greatest interest and importance as regards the distribution of these animals. From the conclusions arrived at in the first volume of this work we know that two species of stegodons (*S. clifti* and *S. insignis*) ranged into China, and we must now extend the range of two species of the genus as far as Japan. *Elephas namadicus* (unless it be the same as *E. antiquus*) has not hitherto been known beyond India, and we must now extend its range from western India to central Japan. It thus seems pretty clear that the Siwalik and Narbada elephants ranged over a great part of India, Burma, China, and Japan. It should be borne in mind that the existing fauna of Japan belongs to the palaearctic region, while the Indian fauna belongs to the Oriental: the past distribution of these fossil elephants seems to indicate a former mingling of the two faunas.

The association of *Stegodon clifti* with *Elephas namadicus* is a point of extreme interest, since the former species occurs so commonly in the Burmese deposits which are probably low down in the Siwalik series. *Stegodon insignis*, if this be the other Japanese species, was already known from the Narbada beds. If the tooth of the mammoth came from the same deposits as the other Japanese remains, there would be considerable probability that these deposits were of pleistocene age: at present we can only say with any approach to certainty that the remains of the Japanese elephants belong to a period not older than the pliocene, during which period some of the same animals flourished in India.¹

The above facts render it necessary that in the table given on page 284 of the first volume, Japan should be added to the distribution of *Euelephas namadicus*, *Stegodon clifti*, and either *S. bombifrons* or *S. insignis*.

In the same table it should also be mentioned that *Loxodon africanus* (African elephant) occurs also in the pleistocene of S. Europe.

¹ Dr. Naumann (*loc. cit.* p. 34) goes, considering the uncertainty of origin of the mammoth tooth, rather farther than the facts appear to me to justify. He observes: "Die japanischen Elefantenreste deuten auf einen Zeitabschnitt hin, der nicht weiter, als in die pliocäne Periode zurückreichen dürfte, und der bis an die jetzige Erdperiode heranreicht."

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA EQUIDÆ.

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

(WITH PLATES XI TO XV.)

Order: UNGULATA. Division: PERISSODACTYLA.

Family: EQUIDÆ.

History of fossil Indian Equidæ.—To quote the words of the editor of Falconer's "Palæontological Memoirs," "no memoir of the fossil Equidæ of India was ever published by Dr. Falconer," and we are, therefore, unacquainted with the particular distinctive characters on which that eminent palæontologist founded the new Indian fossil species named by himself and Sir Proby Cautley. The only means of identifying these species are from the named specimens in the British Museum, and from the (unfortunately small scale) figures in the "Fauna Antiqua Sivalensis."¹

In that great work four species of Indian fossil horses were specifically named; viz., *Equus namadicus* and *Equus palæonius* from the pleistocene of the Narbada valley, and from the sub-Himalayan Siwaliks *Equus sivalensis* and *Hippotherium antilopinum*.

Subsequently to the publication of that work, as we learn from the "Palæontological Memoirs,"² the late M. Ed. Lartet wrote to Dr. Falconer in 1855 to the effect that the so-called *E. palæonius* was the young of either *E. namadicus* or *E. sivalensis*. As the latter species is not yet known from the Narbada rocks, the remark will probably apply to the former. The only specimen of the molar dentition of the so-called *E. palæonius* figured in the "Fauna Antiqua Sivalensis" (pl. LXXXII, fig. 11), shows the lower milk-molars, and there seems no reason for separating this specimen from *E. namadicus*. This accordingly reduces the number of the four species named in the "Fauna Antiqua Sivalensis" to three.

In figure 12 of plate LXXXII of the same work a portion of the mandible of

¹ Pls. LXXXI to LXXXV.

² Vol. I, p. 22, note.

an equine animal from the Siwaliks of the Irawadi valley is figured and referred to the genus *Equus*, without any specific designation. It is impossible to say whether this determination be correct, and whether the specimen does not belong rather to *Hippotherium*. In this uncertainty no description of this specimen will be given in the present memoir.

In their "Catalogue of the Fossil Siwalik Vertebrata in the Museum of the Asiatic Society of Bengal,"¹ Messrs. Falconer and Walker described other remains of fossil Indian Equidæ from the sub-Himalayan Siwaliks and from the ossiferous beds of Perim Island. Among those from the latter place, some specimens are referred to *Equus*, and others to *Hippotherium antilopinum*. An examination of the original specimens referred to the former genus shows that they also belong to *Hippotherium*.

In plate LXXXIV, figures 15 to 19 of the "Fauna Antiqua Sivalensis" some fragmentary limb-bones of horses from the probably pleistocene deposits of Tibet, beyond the Niti pass, are figured under the generic title of *Equus*. Other bones doubtfully referred to the genera *Equus* and *Hippotherium* have also been obtained from the same deposits, but it is probable that these determinations are open to doubt.² From the imperfect and fragmentary condition of the above mentioned remains no attempt at their specific, or even generic, determination can be made, and they will, therefore, be not alluded to at length in this memoir.

Previously to the publication of the "Fauna Antiqua Sivalensis," two notices of the occurrence of fossil horses in India had appeared in the "Journal of the Asiatic Society of Bengal" for 1835. The first of these was in a letter from Dr. Falconer, dated Masûri (Mussoorie), January 1835.³ It mentions the discovery in the Kálawála (Kallowalla) pass of a molar tooth of a horse, which the writer thought might belong to a new species. From the description it is evident that this tooth belonged to a *Hippotherium*. The second notice⁴ is by the late Sir W. E. (then Lieutenant) Baker. An inspection of the plate accompanying that notice shows that the teeth mentioned and figured belong both to *Equus* and *Hippotherium*: the above mentioned tooth of the latter genus from the Kálawála pass is figured (fig. 18) in this notice.

In 1846 Professor Owen⁵ remarked that "the teeth of the extinct slender-legged horse, or Hippother, transmitted by Captain Cautley to the British Museum, are identical with those of the above species [*Hippotherium gracile*] from the European miocene."

In 1862 Professor Gaudry⁶ observed that the limb-bones of *Hippotherium antilopinum* of India very closely resembled those of the slender-limbed variety of *H. gracile* from Pikermi.

¹ The notices referring to the Equidæ are copied in the "Palæontological Memoirs," Vol. I, page 186, *et seq.*

² See a paper by the author, 'Rec. Geol. Surv. Ind.,' Vol. XIV, p. 178.

³ 'Journ. As. Soc., Bengal,' Vol. IV, p. 58.

⁴ *Ibid.*, p. 566, pl. XLV

⁵ "History of British Fossil Mammals and Birds," p. 395.

⁶ "Animaux Fossiles, et Géologie de l'Attique," p. 231.

In 1865 the late Professor H. von Meyer¹ in describing some upper molars of a hippothere collected by the Messrs. Schlagintweit in the Siwaliks of Núrúp and Kúshalghar, came to the conclusion that *Hippotherium antilopinum* of Falconer and Cautley could not be distinguished from the European *H. gracile*, or *E. primum*, as it is called by von Meyer.

In 1870, in the presidential address to the Geological Society of London,² Professor Huxley remarked that traces of the 'larmial' cavities of the skulls of the hippotheres were to be detected in the skulls of some of the Siwalik horses.

In 1873 Professor Gaudry³ mentioned that certain fossil equine teeth from China, in the British Museum, seemed to be identical with those of the Indian hippotheres. In the same memoir⁴ that writer came to the conclusion, from the examination of certain Siwalik limb-bones in the British Museum, figured in the "Fauna Antiqua Sivalensis" as belonging to *Hippotherium antilopinum*, that the feet of that species were unprovided with lateral digits. M. Gaudry concludes his notice by deprecating the assignation of the species in question, on these grounds alone, to a distinct genus. It will be manifest that this conclusion of M. Gaudry rests entirely on the correct determination of the bones in the British Museum assigned to *H. antilopinum*. Some further remarks on this subject will be made in the sequel.

In 1877 certain teeth of the upper molar series of an equine animal from the Siwaliks were described by myself,⁵ under the name of *Sivalhippus theobaldi*. In the same notice it was also mentioned that certain specimens in the Indian Museum seemed to indicate the existence of two Siwalik species of the genus *Equus*, and two of the genus *Hippotherium*. Later on in the same year⁶ it was shown that the so-called *Sivalhippus* was probably the same as the second species of *Hippotherium*, which was accordingly termed *Hippotherium theobaldi*.

In the course of this memoir it will be shown that the second species of Siwalik horse seems to be, in all probability, the same as the pleistocene *Equus namadicus* of Falconer and Cautley, thus affording another instance of the connection of the faunas of the topmost Siwaliks and the Narbada beds.

As the fragment of a lower jaw of an equine animal from the Irawadi and the specimens from Tibet noticed above cannot be, even generically, determined, the known species of fossil Indian equines comprehend two species of *Hippotherium* and two of *Equus*.

List of species of HIPPOTHERIUM and EQUUS.—Since all the remains of fossil horses hitherto discovered in India may be referred to the two genera *Hippo-*

¹ "Paläontographica," Vol. XV, p. 17. I have elsewhere stated that von Meyer added *H. gracile* to the Siwalik fauna, not at first having understood that he intended to group all the Indian remains of that genus under the same name.

² 'P. G. S.,' 1870, p. 1.

³ "Animaux Fossiles du Mont Libéron," p. 32.

⁴ *Ibid.*, p. 40.

⁵ 'Rec. Geol. Surv. Ind.,' Vol. X, p. 31.

⁶ *Ibid.*, p. 82.

therium and *Equus*, we may confine our attention in this memoir to the consideration of those two genera, and, in order to obviate the necessity of quoting synonyms in the sequel, the following list of all the named species of the two genera with which I am acquainted has been drawn up. This list indicates the synonymy, and, in a general way, the geological and geographical distribution of each species. Doubtful species are indicated by an asterisk, while a note of interrogation indicates those instances where there may be doubt as to the identification of a synonym.

GENUS I: HIPPOTherIUM, Kaup.

Synonyms—*Hipparion* (Christol), *Hippodon* (Leidy), *Sivalhippus* (Lydekker).

1. HIPPOTherIUM AFFINE (Leidy sp.). N. America; pliocene.

Hipparion affine (Leidy).

2. HIPPOTherIUM ANTILOPINUM (Falc. and Caut.). India and (?) China; Miopliocene.

Equus primigenius (Von Meyer).

Hipparion antilopinum (Gaudry).

3. HIPPOTherIUM CALAMARIUM (Cope). N. America; pliocene.

4. HIPPOTherIUM GRACILE (Kaup.).¹ Europe and (?) N. Africa; miocene.

Equus angustidens (Meyer).

„ *asinus primigenius* (Meyer).

„ *caballus* (Meyer).

„ *gracilis* (Kaup).

„ *mulus primigenius* (Meyer).

„ *nanus* (Kaup).

„ *primigenius* (Meyer).

Hipparion diplostylum (Gerv.).

„ *gracile* (Christol).

Hipparion gracile, var. *mediterraneum* (Roth. and Wag.)

„ *mediterraneum* (Hensel).

„ *mesostylum* (Gerv.).

„ *prostylum* (Gerv.).

Hippotherium mediterraneum (Kaup).

„ *meridionale* (Kaup).

„ *nanum* (Kaup).

5. HIPPOTherIUM GRATUM (Leidy sp.). N. America; pliocene.

Hipparion gratum (Leidy).

6. HIPPOTherIUM OCCIDENTALE (Leidy). N. America; pliocene.

Hipparion occidentale (Leidy).

7. HIPPOTherIUM PANIENSE (Cope). N. America; pliocene.

8. HIPPOTherIUM SPECIOSUM (Leidy sp.). N. America; pliocene.

Hipparion speciosum (Leidy).

Hippodon speciosus (Leidy).

9. HIPPOTherIUM THEOBALDI (Lydekker). India and (?) China; mio-pliocene.

(?) *Equus primigenius* (Meyer),

Hipparion theobaldi (Blanford).

Sivalhippus theobaldi (Lydekker).

¹ I follow M. Gaudry in uniting *H. mediterraneum* with *H. gracile* (see "Animaux fossiles du Mt. Léberon," p. 32). M. Hansel still considers the two species to be distinct. (See "Abhand. d. k. Akad. d. Wissen. z. Berlin" 1861, p. 27). The only distinction between the two so-called species seems to be a slight difference in the size of the molars and in the folds of the enamel in the lower molars.

10. HIPPOTherium venustum (Leidy). N. America; (?) pleistocene.

Hipparion venustum (Leidy).

GENUS II: EQUUS, Linné.

Synonyms—*Asinus* (Gray), *Hippidion* (Owen), *Hippoideum* (Lund), *Hippotigris* (H. Smith), *Zebra* (Aldrov).

1. EQUUS ARCIDENS (Owen). S. America; pleistocene.

Hippidion arcidens (Owen).

2. EQUUS ARGENTINUS (Burmeister). S. America; pleistocene.

3. EQUUS ASINUS (Linné). Old world; recent and pleistocene.

Asinus vulgaris (Gray).*Equus asina* (Fleming)." *asinus africanus* (Sanson).*Equus zebroides* (Lesson)." " *fossilis* (Owen).

4. EQUUS BURCHELLI (Bennett). S. Africa; recent.

Asinus burchelli (Gray).*Equus montanus* (F. Cuv.)." *zebra* (Burchell).*Equus zebroides* (Lesson).*Hippotigris burchelli* (H. Smith).5. EQUUS CABALLUS (Linné). Old World and (?) N. America¹; recent, pleistocene, and upper pliocene.*Equus adamiticus* (Schloth.)." *antiquorum* (Gesner)." *brevirostris* (Kaup)." *caballus fossilis* (Baer)." *? derillei* (Gervais)." *ferus* (Pallas)." *juvillacus* (Bravard)." *fossilis* (Meyer)." *? fraternus* (Leidy).*Equus magnus* (Bravard)." *? micrognathus* (Gervais)." *minulus* (Dub. and Jacm.)" *? piscenensis* (Gervais)." *placidens* (Owen)." *? priscus* (Eichwald)." *robustus* (Pomel)." *spelæus* (Owen).6. EQUUS CONVERSIDENS (Owen). S. America¹; pleistocene.

7. EQUUS CURVIDENS (Owen). S. America; pleistocene.

8. EQUUS HEMIONUS (Pallas). Central Asia; recent.

Asinus equioides (Hodgson)." *equuleus* (H. Smith)." *hemionus* (Gray)." *hippargus* (H. Smith)." *kiang* (Gray).*Asinus polyodon* (Hodgson)." *? hemippus* (?)*Equus kiang* (Moorcroft)." *onager* (Eversman)." *varius* (H. Smith in part).

9. EQUUS MAJOR (De Kay). N. America; (?) pliocene.

Equus americanus (Leidy). *Equus complicatus* (Leidy).¹ The introduced American and Australian horses are not noticed here.

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10. *EQUUS NAMADICUS* (Falc. and Caut.). India; pleistocene and (?) pliocene, (Narbada and (?) Sub-Himalaya).
? *Equus palæonius* (F. and C.)
11. *EQUUS NEOGÆUS* (Lund). S. America; pleistocene.
Hippidion neogæum (Owen). | *Hippidæum neogæum* (Lund).
12. **EQUUS OCCIDENTALIS* (Leidy). N. America; pliocene.
Equus excelsus (Lund).
13. *EQUUS ONAGER* (Pallas). Kach, Persia, and Mesopotamia; recent.
Asinus hemionus (Gray). | *Equus asinus onager* (Schred).
" *kiang* (Layard). | " *hemionus* (Sykes).
" *onager* (Gray). | " *khur* (Lesson).
14. *EQUUS PACIFICUS* (Leidy). N. America; pleistocene.
15. **EQUUS PREZEWALSKI* (Poliakoff). C. Asia; recent.
16. *EQUUS PRINCIPALIS* (Lund). S. America; pleistocene.
Hippidion principalis (Owen).
17. *EQUUS QUAGGA* (Gmel.). S. Africa; recent.
Asinus quagga (Gray).
18. *EQUUS QUAGGOIDES* (F. Maj.) Europe; pliocene.
19. *EQUUS SIVALENSIS* (Falc. and Caut.). India; pliocene.
20. *EQUUS STENONIS* (Cocchi). Europe; up. pliocene.
21. *EQUUS TAU* (Owen). S. America; pleistocene.
22. *EQUUS ZEBRA* (Linné). S. Africa; recent.
Asinus zebra (Gray). | *Hippotigris antiquorum* (H. Smith).
Equus brasiliensis (Jacob). | *Zebra indica* (Aldrov.).
" *indicus* (Jonston).

This list gives a total of 10 species of *Hippotherium*, all of which are fossil, and whose distribution may be tabulated as follows, viz. :—

India and China	2
Europe and Africa	1
America	7

Of the genus *Equus*¹ there are 22 species, of which 8 are living, 2 are found both living and fossil, and 14 are exclusively fossil: their distribution may be tabulated as follows :—

	Living.	Fossil.
Africa	5	0
Asia	5	2
Europe	2	3
North America	0	4
South America	0	7

Dentition of the Equidæ.—As the materials for the history of the fossil Siwalik

¹ *Equus parvulus* (Marsh) = *Protohippus*.

horses consist mainly of teeth and jaws, it will avoid repetition to devote a few paragraphs to the consideration of the structure and number of the teeth in the two genera under consideration. In all the known genera of the family the whole complement of the full mammalian dentition is invariably developed, the formula being—

$$\begin{array}{cccc} i & 3:3 & c. & 1:1 & pm. & 4:4 & m. & 3:3 \\ & 3:3 & & 1:1 & & 4:4 & & 3:3 \end{array}$$

The tooth here reckoned as the first premolar is in *Equus* and *Hippotherium*, at all events, a milk-molar, as it has neither predecessor nor successor; it is of small size, and, in most cases, disappears at an early age. It is analogous to the corresponding tooth in *Rhinoceros*. In *Equus* "the molar teeth present an outer wall, which is bicuspidate in transverse section; and two inner edges, which are curved more or less inwards and backwards, and correspond respectively with the anterior and posterior crescents of the outer wall. The valleys may be more or less completely filled up with cement, which also coats the tooth. The incisors are similar in form in each jaw, and in *Equus* and *Hippotherium* their crowns present a wide and deep median cavity, formed by a fold of enamel."—(Huxley.)

The structure of the molars may be more fully explained as follows, in the words of the same writer:—

"The outer wall of the tooth is bent in such a manner as to present from before backwards two concave surfaces, separated by a vertical ridge. From the anterior end, and from the middle of this outer wall, two laminae of the crown pass inwards and backwards, so as to be convex inwards and concave outwards, and thus to include two spaces between themselves and the outer wall. From the inner surface of the hinder part of each of these crescentic laminae a vertical pillar is developed, and the inner surface of the pillar is grooved vertically. The outer wall, the laminae, and the pillars are all formed of dentine and enamel, thickly coated with cement. The attrition which takes place during mastication wears down the free surfaces of all these parts, so as, in the long run, to lay bare a surface of dentine in the middle of each, surrounded by a band of enamel, and outside this by the cement, with which the interspaces are filled. The band of enamel is simple and unplaited [in the young, but somewhat plaited in the adult.] The general pattern of the worn crescentic surface may be described as consisting, externally of two longitudinal crescents, one behind the other, and with their concavities turned outwards. [In plate XIV, fig. 3 the component parts of the teeth are indicated in pm. 3. In this tooth *a* and *b* are the outer crescents, which will be termed below, respectively, the anterior and posterior, or first and second, outer crescents.] * * Internal to these, are two other crescents, partly transverse in direction, and connected by their anterior ends with the walls, which arise from the wear of the laminae; [these crescents are indicated by the letters *c* and *d*, and will be termed, respectively, the anterior and posterior, or first and second inner crescents,] and attached to the inner surface of these two hour-glass-shaped surfaces produced by the wear of the two pillars. [These pillars are indicated, by the letters *e* and *f*, and will be designated, respectively, the anterior and posterior, or first and second pillars.]

"In the mandible the structure of the molars and the resulting pattern are quite different. [The right hand tooth in figure 5 of plate XII is selected to illustrate the structure of the lower molars.] The outer wall presents two convex surfaces, separated by a longitudinal depression, and thus reverses the conditions observable in the upper molars. The result of the wear of this is

necessarily, two crescents, the concavities of which are turned inwards. [These crescents are indicated by the letters *a* and *b* in the figure, and will be alluded to respectively as the anterior and posterior, or first and second crescents.] A vertical pillar, longitudinally grooved on its inner face, is developed on the inner face of the tooth at the junction of the anterior and posterior crescent, and gives rise to a deeply bifurcated surface when worn. [This pillar is indicated by the letter *c*, and will be termed the anterior or first pillar.] A second smaller pillar appears in connection with the inner face of the posterior end of the outer wall." [This pillar is indicated by the letter *d*, and will be termed the posterior or second pillar.]

Homology of component parts of molars.—The homology of the component parts of the equine molar with those of the molars of a less specialised type (*e.g.*, *Anchitherium* and *Rhinoceros*) has been admirably pointed out by M. Gaudry.¹ That distinguished palaeontologist has shown that the outer 'crescents' of the upper molars of the horse correspond to the two divisions of the outer wall of the rhinoceros molar,² while the inner 'crescents' correspond to the areas connecting the two main 'colles' with the outer wall, and the two 'pillars' to the 'colles' themselves. The central spaces enclosed between the two transverse pairs of 'crescents' in the equine molar, correspond to the median and posterior 'valleys' of the rhinoceros molar. In the lower molars the outer 'crescents' of the equine tooth correspond to the greater part of the 'crescents' of the rhinoceros molar, while the 'pillars' of the former correspond to the postero-internal extremities of the latter.

Development.—The milk-dentition has the following formula:—

$$\text{m. i. } \frac{3 \cdot 3}{3 \cdot 3} \quad \text{m. c. } \frac{1 \cdot 1}{1 \cdot 1} \quad \text{mm. } \frac{4 \cdot 4}{4 \cdot 4}$$

The first true molar comes into use long before the milk-molars are shed. In the living horse the first milk-molar usually falls out at the time of appearance of the second premolar, and is never replaced. In some of the Indian domestic ponies this tooth is retained for a longer period, and we shall see such to have been the case among some of the Siwalik horses. The permanent canines are the last to appear, and they are not unfrequently never developed in the domesticated mare. "The upper canines are distant from the outer incisors, while the lower canines are quite close to them. In both jaws there is a wide interval, or *diastema*, between the canines and the premolars."

Special characters.—The last molar is not more complex than the anterior teeth, nor the last milk-molar than the replacing premolar. This is a common perissodactyle, as distinguished from an artiodactyle, character. The molars and premolars do not form 'fangs' till late in the life of the animal.

In the horses and hippotheres the three last premolars are larger than the true molars, and the first premolar (milk-molar) very small, but in the older members of the family all the teeth of the molar series are more equal in size.

Distinction between molars of HIPPOTherium and Equus.—The upper molars of *Hippotherium* are distinguished from those of *Equus*, in an early state of wear, by

¹ "Les Enchainements du Monde Animal, etc.," Chap. V.

² Vide preceding fasciculus.

the complete isolation of the anterior 'pillar': in the much-worn tooth, however, this 'pillar' is united to the first inner 'crescents' in *Hippotherium*, as in *Equus*.¹ The plications of the central folds of enamel in the upper molars are generally greater in the former than in the latter genus.

Genus I. HIPPOTHERIUM, Kaup.

HIPPARION, Christol.

This genus may be shortly defined as follows. Tridactyle² horses, in which the first pillar, in the upper molars, is disconnected from the first inner 'crescent' for at least three-quarters of its length.

Species 1. HIPPOTHERIUM ANTILOPINUM, Falc. and Caut.

Syns: HIPPARION ANTILOPINUM, Gaudry. EQUUS PRIMIGENIUS, von Meyer.

History.—As stated in the introduction, this species seems to have been first named in the "Fauna Antiqua Sivalensis," and we must, therefore, trust to the figures there given, and the measurements in the descriptions of the plates, for its identification. In plate LXXXII of that work there are drawn several specimens of the dentition, which must be taken as the types of the species. These will be referred to as we proceed.

At a later period, as already noticed in the introduction, H. von Meyer referred all the remains of Indian hippotheres then known, to the European *Hippotherium gracile* (*Equus primigenius*). We shall subsequently see that there is good evidence to show that there are, at least, two Indian species of the genus, but that von Meyer's conclusion as to the identity of *H. antilopinum* with *H. gracile* may possibly be correct.

M. Gaudry's conclusion as to the probable monodactyle character of this species will be alluded to below and shown to be untenable.

Upper molar series.—In figure 13 of plate LXXXII of the "Fauna Antiqua Sivalensis," an upper jaw, with the molar series, of *Hippotherium antilopinum* is figured, and described as belonging to the left side. A cast of this specimen, however, in the Indian Museum, shows that the figure has been reversed, and that the jaw really belongs to the right side. It contains six teeth, which seem to be the three true molars, and the three last premolars. The portion of the bone where the persistent milk-molar should be has been broken away, so that that tooth

¹ Vide Gaudry, *op. cit.*, fig. 166.

² This is on the supposition that M. Gaudry's conclusions as to the monodactyle character of *H. antilopinum* are incorrect.

may have been present in the complete jaw. The last true molar has only just come into wear. This specimen will be termed *a*.

In figure 16 of the same plate a palatal specimen is figured; it shows the three true molars and the last premolar; it is of slightly larger size than the last specimen and will be alluded to as specimen *b*.

In figure 18 of the same plate a detached upper molar is figured of the natural size.

In figure 1 of plate XI of this memoir there is drawn part of the left upper molar dentition of a species of *Hippotherium*, collected by Mr. Theobald in the Siwaliks of Niki, in the Punjab. The second tooth in this specimen (pm. 4) being less worn than the succeeding tooth, is inferred to be the last premolar, whence the four teeth will be, respectively, the 3rd and 4th premolars (pm. 3, pm. 4) and the 1st and 2nd true molars (m. 1, m. 2). From the size of the teeth in this specimen (which we shall call specimen *c*) it is inferred to belong to *H. antilopinum*. The teeth are of the normal hippotherian type, showing the characteristic isolated anterior 'pillar,' and the plications of the central islands of enamel. The premolars are somewhat larger than the true molars, and the grinding surfaces of all the teeth are approximately square.

In the following table the dimensions of the three specimens above noticed are compared together; the specimens are indicated by the letters given above—

	a.	c.	b.
Width of palate posteriorly . . . . .	...	...	2'0
" " " between 3rd premolars . . . . .	...	...	1'9
Length " molar series	5'3	...	...
" " three true molars	2'36	...	2'5
" " 1st premolar	1'25	...	—
Width " " "	0'83	...	...
Length " 2nd "	0'96	0'96	...
Width " " "	0'95	0'95	...
Length " 3rd "	0'93	0'9	0'9
Width " " "	0'86	0'91	0'9
Length " 1st true molar	0'8	0'81	0'8
Width " " "	0'85	0'88	0'9
Length " 2nd "	0'85	0'82	0'8
Width " " "	0'76	0'78	0'85
Length " 3rd "	0'8	...	0'85
Width " " "	0'55	...	0'75

The comparatively slight variations in these dimensions leave little room for doubt that the three specimens belong to the same species, seeing that no difference in the form of the teeth can be detected.

Upper milk-molars.—The next specimen for notice is the anterior portion of the palate of a colt, also collected by Mr. Theobald in the Siwaliks of the Punjab near the village of Niki. In figure 2 of plate XI of this volume the dentition of the left side of this specimen is figured. The teeth shown are the four milk-molars (mm. 1 to mm. 4.), and the germ of the first true molar (m. 1), which has never come into

use. The isolation of the anterior 'pillars' in these teeth shows that they belong to a *Hippotherium*, while the existence of a larger form of milk-molars of the genus in the Siwaliks (to be noticed in the sequel) renders it probable that these teeth belong to the present smaller species.

The first milk-molar (mm. 1) is a small sub-cylindrically shaped tooth: the second milk-molar (mm. 2) is elongated; the third and fourth teeth of this series (mm. 3: mm. 4) approach a square in cross=section.

As it is mainly from the characters of the upper milk-molars that the distinctness of the next species is inferred, it will be necessary to examine the characters of these teeth somewhat more closely. In all the three larger teeth the anterior 'pillar' is subcylindrical, and is placed far in between the two inner 'crescents,' so that by the presence of a large amount of cement the inner wall of the crown presents a smooth face, without any projection of the hinder border of the anterior 'pillar.' In the second milk-molar there is an infolding of enamel on the inner side of the produced anterior extremity of the crown: the posterior 'pillar' presents the peculiar character of being separated from the posterior inner 'crescent.' In the second and third milk-molars the posterior 'pillar' does not extend backwards as far as the hinder border of the crown. In all these teeth the plications of the enamel in the central islands are of great complexity. The teeth are coated very thickly with cement, which nearly obliterates the ridges on their outer walls.

The dimensions of the specimen are as follows:—

Width " of palate between 1st milk-molars	1.82
" " " last "	2.0
Length " four milk-molars	3.72
" " three last "	3.52
" " 1st milk-molar	0.48
Width " "	0.32
Length " 2nd "	1.42
Width " "	0.89
Length " 3rd "	1.01
Width " "	0.94
Length " 4th "	1.1
Width " "	0.94

Mandible.—In figures 14 and 14a of plate LXXXII of the "Fauna Antiqua Sivalensis" two views are given of a fragmentary mandible of a small equine animal referred to the present species. In the description of the plate the specimen is said to contain the three premolars and the first true molar: an inspection of the figure, however, shows clearly that the fourth tooth (the first true molar) is less worn than the preceding tooth; hence the three anterior teeth must be milk-molars, and not premolars. I am unable to say whether the specimen belongs to this or the next species.

In figure 3 of plate XII of this volume there is drawn a fragment of the left ramus of the mandibæ of an equine animal collected by Mr. Theobald in the

Siwaliks of the Punjab. As the specimen comes from a horizon in the Siwaliks (as inferred from its mineral condition), where no remains of *Equus* occur, and as it presents certain peculiarities characteristic of the lower dentition of *Hippotherium*, it may be referred to that genus. Since the specimen is smaller than, and of different proportions from, another jaw of the same genus referable to the next species, it seems probable that it may be referred to *H. antilopinum*. This specimen shows five teeth, the two anterior of which (pm. 3, pm. 4) are stouter and less worn than the succeeding tooth (m. 1.) whence it is inferred that the five teeth are respectively the two last premolars, and the three true molars.

The premolars (pm. 3, pm. 4) are considerably wider and stouter than the true molars; the last true molar is extremely thin: the four anterior teeth exhibit at their antero-external angles a semi-detached column of enamel, very characteristic of the lower molars of this genus.¹ The fragment of the mandible remaining shows that the inferior border was highly convex towards the middle.

The dimensions of the specimen are as follows:—

Depth	of jaw at pm. 3	2.1
"	" " m. 1	2.65
Length	" five teeth	5.0
"	" three true molars	2.32
"	" 3rd premolar	1.08
Width	" " "	0.61
Length	" 4th "	1.1
Width	" " "	0.6
Length	" 1st true molar	0.94
Width	" " "	0.5
Length	" 2nd "	0.96
Width	" " "	0.48
Length	" 3rd "	1.02
Width	" " "	0.43

Lower milk-molars.—In figure 1 of plate XII there is represented a part of the left mandible of a young hippothere, collected by Mr. Theobald in the Punjab. This specimen shows four teeth, namely, the three last milk-molars (mm 2, mm 3, mm. 4), (inferred to be such from the fourth tooth (m. 1) in the specimen being less worn than the preceding one), the first true molar (m. 1) just touched by wear, and the alveolus of the second true molar. The specimen is inferred to belong to a *Hippotherium* from the district whence it was obtained, and from the presence of the detached column of enamel on the outer side of the third milk-molar. From the exact similarity of the first true molar (m. 1) in this specimen with the corresponding tooth in the last specimen, the jaw is inferred to belong probably to *H. antilopinum*. It will be noticed that the milk-molars are of smaller dimensions than the premolars in the last specimen. The length of the three milk-molars is 3·7 inches.

¹This column is scarcely perceptible in the figure; it is well shown in figure 10 of plate V of Gaudry's "Animaux Fossiles du Mont Léberon."

Limb-bones.—In plates LXXXIV and LXXXV of the “Fauna Antiqua Sivalensis” a large series of limb-bones of Siwalik equine animals has been lithographed, and in many cases specifically assigned either to *Equus sivalensis* or *Hippotherium antilopinum*. We are not, however, informed on what grounds these determinations were made, but it appears that in general the larger specimens have been assigned to the former species, and the smaller to the latter. If, however, we examine into the matter more closely, we shall find that this does not hold as an invariable rule. Taking the case of the metatarsus, we find that in figure 4 of plate LXXXIV a specimen of this bone referred to *Equus sivalensis* has a length of 11·1 inches; while a specimen (plate LXXXV, figure 12) referred to *Hippotherium antilopinum* has a length of 10·4 inches. Another specimen, however (plate LXXXIV, figure 21), assigned to the former genus, has a length of only 10·5 inches, and is much slenderer than the first specimen. In the Indian Museum there is a specimen of an equine metatarsus from the topmost Siwaliks, in which hitherto no remains of *Hippotherium* have been found: this bone is somewhat smaller than the one assigned by Falconer and Cautley to *H. antilopinum*, and yet belongs to an *Equus*. It will be shown below that the proximal phalangeal bones referred by Falconer and Cautley to *H. antilopinum* really belong to *Equus sivalensis*.

From the foregoing considerations it seems to me that Falconer's identification of the limb-bones of this species is certainly erroneous, and, therefore, that M. Gaudry's conclusions as to the probable monodactyle character of *H. antilopinum*, based on the absence of the facettes for the lateral metacarpals or tarsals, on the ‘cannon-bones’ assigned to this species by Dr. Falconer, must likewise fall to the ground. It may be observed, however, that if, as was almost certainly the case, the hippotheres have been gradually modified into the true horses, they must at some time or other have lost their accessory digits, and the anterior ‘pillar’ of the upper molars must have been become connected with the main body of the tooth. It is quite possible, therefore, if not probable, that these changes did not take place synchronously, and, accordingly, there would be nothing improbable in meeting with an animal having, as M. Gaudry considers to have been the case with the present species, the digitation of the horse, coupled with the dentition of the hippothere.

There are but few limb-bones in the Indian Museum, which can with any certainty be referred to this species. Among these may be mentioned the proximal phalangeals, which are of the same shape as the corresponding bone of the next species (plate XIII), but about two-thirds the size. They are quite different from the bone assigned by Falconer to this species in the “Fauna Antiqua Sivalensis,” plate LXXXIV, figure 11.

Comparison with H. gracile.—As far as can be judged, it appears probable that Dr. Falconer distinguished his Indian hippothere from the European species on the ground of its smaller size. M. Gaudry, however, in his great works on the Pikermi and Mount Léberon fossils, has shown that the latter species is subject

to such variation in size,¹ that it would seem that this ground of distinction will not hold; and we are, therefore, driven to depend on the characters of the teeth themselves. This renders the task of indicating precise specific characters one of great difficulty, as there are such extremely insignificant differences between the teeth of all the species of the genus.

Between the four middle upper molars of *H. antilopinum* figured here, and the corresponding teeth of *H. gracile*, I cannot find any crucial point of distinction, and they might, as far as I can judge, be referred to the same species. Almost the only difference seems to be that in the Indian form the anterior 'pillar' is more completely enclosed in the cement, and is hence less conspicuous on the inner surface.

In the upper milk-molars a few points of difference can be detected between the European and Asiatic forms. In the former² the plications of the central enamel islands are less complex than in the latter; while the anterior 'pillars' are less completely embraced in the crowns of the teeth in the former. In the second milk-molar of *H. gracile* both the 'pillars' are connected with the 'crescents' by isthmuses of dentine, while in the corresponding tooth of *H. antilopinum* both are completely isolated. Further, in the same tooth of the latter there is a distinct infold of enamel from the inner side of the produced anterior angle, which is entirely wanting in the corresponding tooth of the former.

The mandible of the Indian form is decidedly more curved inferiorly than that of the European form.

It will be seen, therefore, that the points distinguishing *H. antilopinum* from *H. gracile* are extremely slight, and it is not improbable that von Meyer's identification of the two may be correct. It appears to me best, however, seeing that there are some minute points of difference, to retain, at all events for the present, the two specific names, though it may be doubted whether the two forms should be ranked as races or species.

American hippotheres.—All the American species of the genus seem to be distinguished by the simpler structure of the enamel folds. Should any of them, which is extremely unlikely, turn out to be the same as the Indian species, the name of the latter has the priority of all.

Distribution.—Remains of this species have been obtained throughout the sub-Himalayan Siwaliks, but not from Sind or Burma. An atlas of a small species of horse in the Indian Museum from Perim Island has been referred by Dr. Falconer, with considerable probability of correctness, to the present species. It is uncertain whether the hippotherian teeth from China in the British Museum, mentioned by M. Gaudry in the passage already quoted, should be referred to this or the next species.³

¹ Compare fig. 7, pl. XXXIV of "Animaux Fossiles et Géologie de l'Attique," with fig. 9 of pl. V, of "Animaux Fossiles du Mont Léberon."

² See "Animaux Fossiles du Mont Léberon," pl. V, fig. 7.

³ These teeth are referred to in the "Quarterly Journal of the Geological Society of London." Vol. IX, p. 354.

Species 2. *HIPPOTHERIUM THEOBALDI*, *nobis*.Synonyms—*EQUUS PRIMIGENIUS*, Meyer, *SIVALHIPPIUS THEOBALDI*, *nobis*.

History.—As stated in the introduction, certain remains of this species were originally described,¹ as belonging to a new genus, under the name of *Sivalhippus theobaldi*. It was, however, subsequently discovered² that the teeth on which this new genus had been founded, in place of being premolars, as was originally considered to be the case, were really milk-molars, and were then seen to belong to *Hippotherium*. It was added in the same notice that certain teeth described by H. von Meyer³ from India, as belonging to *H. gracile*, should be referred to the new species under the name of *H. theobaldi*. It may be added that this determination was made under the erroneous impression that von Meyer had intended to distinguish the teeth in question from *H. antilopinum*, whereas he had intended to unite that species with *H. gracile*. The distinctness of this species rests solely on the characters of the upper milk-molars, the true molars, which are referred to it, presenting no characters, except their larger size, by which they can be sufficiently distinguished from those of *H. antilopinum*, and, as far as I can judge, closely resembling the corresponding teeth of the larger variety of *H. gracile*.

Upper milk-molars.—The teeth of the specimen on which the species was originally founded are represented in figure 4 of plate XI. The specimen was obtained by Mr. Theobald from the Siwaliks of the village of Kaipar, in the Punjab. It consists of a fragmentary portion of the left maxilla, containing three complete teeth (mm. 2, mm. 3, mm. 4) and the broken base of a smaller anterior tooth (mm. 1). To the rear of the last tooth (mm. 4) there is seen the alveolus of a fifth tooth, which had not come into use at the death of the animal: this shows that the existing teeth belong to the milk-molar series. From the isolation of the anterior 'pillars' of the molars the specimen must be referred to *Hippotherium*, while from the great difference in the form of these teeth from the upper milk-molars of *H. antilopinum*, drawn in figure 2 of the same plate, it is inferred that they must be assigned to a second Indian species of the genus, which it has been proposed to call *H. theobaldi*.

The teeth belonged to a very young colt, as they are but slightly touched by wear. In spite, however, of the very small degree of attrition of these teeth, the first true molar had cut the gum, as is shown by the condition of its alveolus. This unusually early appearance of this tooth seems to distinguish this jaw from the jaws of all other horses.

The first tooth was small and sub-cylindrical. The remaining teeth are oblong in shape (the second milk-molar being produced into the usual angle), and, thereby, seem to be distinguished from those of other species of the genus, which are more

¹ R. G. S. L., Vol. X, p. 31.² *Ibid*, p. 82.³ "Paläontographica," Vol. XV, p. 17.

nearly square in shape;¹ and in which respect they resemble the milk-molars of the genus *Equus*.

The points distinguishing these teeth from the corresponding teeth of *Hippotherium antilopinum* will be best exhibited by a comparison of the two series. In the following table the dimensions of the specimen under consideration are given in the first column, and those of the corresponding teeth of *H. antilopinum* in the second.

Length of three last milk-molars	. . . . .	4.0	3.52
" " first milk-molar	. . . . .	0.32	0.48
Width " " "	. . . . .	...	0.32
Length " second " "	. . . . .	1.55	1.42
Width " " "	. . . . .	0.98	0.89
Length " third " "	. . . . .	1.28	1.01
Width " " "	. . . . .	0.96	0.94
Length " fourth " "	. . . . .	1.30	1.1
Width " " "	. . . . .	0.97	0.94

These dimensions show the much greater proportionate length of the milk-molars of the former species. The other differences are the following.

In *H. antilopinum*, the anterior 'pillar' is sub-cylindrical, and completely enclosed by cement in the mass of the crown: the posterior 'pillar' does not extend backwards as far as the hinder border of the crown; while in the second milk-molar the same 'pillar' is disconnected from the body of the tooth. The enamel is much plicated, and the cement of great thickness.

In *H. theobaldi*, on the other hand, the anterior 'pillar' is much compressed, so as to be longitudinally elongated; it also stands out distinctly from the crown, so that its posterior border forms a free sharp edge: the posterior 'pillar' extends backwards as far as the hinder border of the crown; while in the second milk-molar the same 'pillar' is united with the adjacent 'crescent.' The enamel is but slightly plicated, and the cement thin.

These points of distinction appear to me so marked as to preclude all idea of referring the two specimens to the same species. It may be noticed that in nearly all the points in which the milk-molars of *H. theobaldi* differ from those of *H. antilopinum* (and also from those of *H. gracile*) they approach the characters of the corresponding teeth of *Equus*. It will be observed that 'sprigs' of enamel jut forth from the space between the two 'crescents' very close to the anterior 'pillar,' foreshadowing the connection which exists in *Equus*.

The milk-molars of *H. gracile*, as has been noted above, are so like those of *H. antilopinum*, that we have found very few points of distinction: hence the milk-molars of *H. theobaldi* will differ from those of *H. gracile* in much the same points as they do from those of *H. antilopinum*. According to M. Gaudry's figure of the milk-molars of *H. gracile*, these teeth seem to be slightly more elongated than those of *H. antilopinum*, and are therefore intermediate between the latter and those of

¹ Vide plate XI, fig. 2, and plate V fig. 7, of " Animaux Fossiles du Mont Léberon."

H. theobaldi. The second milk-molar of the latter species agrees with the corresponding tooth of *H. gracile* in the union of the posterior 'pillar' with the adjacent 'crescent,' and differs by the presence of the infold of enamel at the inner side of the anterior angle.

Second specimen.—In a second specimen of the milk-molars of *H. theobaldi* (Indian Museum, No. C. 154) from Niki, containing the two last teeth of that series, the essential characters are the same as in the type specimen: the dimensions are as follows:—

Length of third milk-molar	. . . . .	1.12
Width " " "	. . . . .	0.87
Length " fourth "	. . . . .	1.2
Width " " "	. . . . .	0.88

The disproportion between the two diameters is here greater than in the first specimen.

Maxilla of first specimen.—The fragment of the maxilla in which the figured teeth are contained is too imperfect to give any idea of the characters of the cranium, except the fact that it was furnished with a very large lachrymal depression or 'larmier.'

Distinctness as a species.—I am unable to find in any of those of the American species of *Hippotherium* of which the milk-molars have been described any close resemblance to the teeth described above, and therefore come to the conclusion that they are rightly referred to a distinct species.

Upper true molars.—Seeing that the upper milk-molars have afforded evidence of two species of Indian hippotheres, it now remains to discover whether we can distinguish between the true molars of these species. In figure 3 of plate XI, there are represented four teeth of the left upper permanent molar series of a hippothere from Mr. Theobald's Niki collection, of somewhat larger dimensions than those of *H. antilopinum*, and also differing slightly in form from those teeth. Since the upper milk-molars of *H. theobaldi* are somewhat larger than those of *H. antilopinum*, it is inferred that the same rule holds good with regard to the true molars, wherefore the teeth in question have been assigned to the former species. It may be added that if the milk-molars had not been known, it would have been doubtful whether the true molars would have afforded ground for the formation of two species.

The figured specimen consists of a fragment of the left maxilla containing four complete teeth, and the alveolus of another tooth on either side of the four remaining ones. The second remaining tooth, counting from the left (p. m. 4), is less worn than either of the teeth on its two sides, and must accordingly be the last premolar: the four teeth will, therefore, be respectively the third and fourth premolars (p. m. 3, p. m. 4), and the first and second true molars. The crowns of the teeth are nearly square in cross-section, and the premolars are considerably larger than the true molars. The anterior 'pillars' are compressed longitudinally, and stand out distinctly from the crown: small processes of enamel project from the space

between the inner 'crescents' towards these 'pillars.' The posterior 'pillars' are constricted at the point of union with the posterior 'crescents;' this constriction, however, is only characteristic of an early stage of detrition and disappears at a later period, as is shown in the single worn tooth represented in plate XIII, figure 1. The enamel is much plicated.

In figures 1 and 2 of plate XIII are represented two detached upper molar teeth of the same species, the first of which (fig. 2) is the second right premolar; and the other, the third or fourth of the left side of the same series. The former tooth is figured to show the characters of the first premolar, and the second to show a good example of a well-worn crown of one of the middle teeth. The only point that claims any particular notice is that there is a plication of the enamel on the inner side of the produced anterior angle of the second premolar, which seems to be constant in all specimens of this tooth.

The dimensions of the three last premolars, and the second and third true molars, are as follows :—

Length of four teeth of specimen drawn in plate XI, fig. 3	44
Length „ second premolar	16
Width „ „ „	11
Length „ third „	124
Width „ „ „	112
Length „ fourth „	113
Width „ „ „	115
Length „ first true molar	10
Width „ „ „	105
Length „ second „ „	103
Width „ „ „ „	103

Distinctions and differences.—As I have before observed, it seems doubtful whether the evidence of the permanent molars alone would have been sufficient for the separation of the present species from the last; seeing, however, that the milk-molars afford undoubted evidence of the distinctness of the two, we may note what points of difference can be found between the permanent molars. It will first of all be seen from the measurements given above that the permanent molars of *H. theobaldi* are of considerably larger size than those of *H. antilopinum*; in the former species, moreover, the excess of size of the premolars over the true molars is considerably greater than in the latter. The anterior 'pillars' in the molars of the former are more compressed laterally, and stand out more distinctly from the body of the teeth than in the latter. These appear to be the main points of difference between the permanent molars of the two species.

The permanent molars of *H. gracile* seem to be in general somewhat smaller than those of *H. theobaldi*; while their anterior 'pillars' are more cylindrical. The projections of enamel from the space between the two inner 'crescents' do not approach so near to the anterior 'pillars' in the former as in the latter. In the second premolar of the European species the folds of the enamel occurring on the inner side of the anterior angle of this tooth in the Indian species are wanting.

I cannot identify the molars of the present species with any of the American species of the genus, which are mostly characterised by their smaller size, and by the lesser degree of plication of the central enamel islands.

Mandible.—In figure 2 of plate XII there is figured a portion of the left ramus of the mandible of a *Hippotherium*, obtained by Mr. Theobald in association with the maxilla last described, and which doubtless belonged to the same individual. The specimen was, in all probability, originally complete, but has been broken, and lost some pieces during the process of extraction from its bed. The parts now remaining comprise the greater part of the left ramus, from the base of the coronoid process to the commencement of the symphysis, but wanting a small part of the middle, and the last premolar. The other fragment consists of the hinder half of the right ramus as far as the front of the last premolar. The figured fragment shows the second and third premolars (pm. 2, pm. 3), and the three true molars (m. 1 to m. 3), while the right ramus contains the last premolar and the true molars.

The jaw belonged to an animal which had just attained to full maturity, as the last true molar has been but a short time in use. The first premolar, or milk-molar, has disappeared. The teeth are of large size and great thickness, and the premolars are much larger than the true molars.¹ The cement is of unusual thickness, forming distinct ledges on the sides of the crown. The free edges of the enamel are slightly crenulated. The inferior border of the ramus is nearly straight below the molars, and the inflection for the symphysis commences one inch in advance of the second premolar. The dimensions of the specimen (combining those of the two rami) are as follows:—

Length of six molars	.	.	.	.	.	.	.	.	6·8
Depth „ jaw at second premolar	.	.	.	.	.	.	.	.	2·08
„ „ „ last true molar	.	.	.	.	.	.	.	.	4·1
Length „ second premolar	.	.	.	.	.	.	.	.	1·3
Width „ „ „	.	.	.	.	.	.	.	.	0·72
Length „ third „	.	.	.	.	.	.	.	.	1·13
Width „ „ „	.	.	.	.	.	.	.	.	0·8
Length „ fourth „	.	.	.	.	.	.	.	.	1·12
Width „ „ „	.	.	.	.	.	.	.	.	0·75
Length „ first true molar	.	.	.	.	.	.	.	.	1·0
Width „ „ „ „	.	.	.	.	.	.	.	.	0·68
Length „ second „ „	.	.	.	.	.	.	.	.	1·07
Width „ „ „ „	.	.	.	.	.	.	.	.	0·62
Length „ third „ „	.	.	.	.	.	.	.	.	1·3
Width „ „ „ „	.	.	.	.	.	.	.	.	0·61

Distinctions and differences.—The above dimensions indicate an animal of somewhat larger size than the Tibetan kiang (*Equus hemionus*). The teeth are larger and stouter than those we have assigned to *H. antilopinum*, the increase of thickness being due in great part to the large quantity of cement. The inferior border of the jaw seems to be straighter than in that of *H. antilopinum*. Much

¹ In the figure the space left for the last premolar is not of sufficient length.

the same differences occur between the present teeth and the lower molars of *H. gracile*. The jaw of *H. theobaldi* is further distinguished from that of *H. gracile* by the smaller interval separating the first of the molar series from the commencement of the symphysis.

In figure 4 of plate XII there are represented the teeth of a broken right ramus of the mandible of an equine animal collected by Mr. Theobald at Jabi, in the Punjab. The specimen shows the last premolar (pm. 4) and the three true molars (m. 1, m. 2, m. 3). As no remains of the genus *Equus* have been obtained from the district where this specimen was collected, it is inferred to belong to *Hippotherium*. In the dimensions of the jaw and length of the teeth, the specimen agrees with the above described jaw of *H. theobaldi*. The teeth differ, however, from those of the latter specimen by the enormous quantity of cement with which they are coated, especially noticeable in the premolar. The 'crescents' seem also to be less regular in form than in that specimen. A third mandible in the Indian Museum (No. C. 161) exhibits less cement than the specimen drawn in figure 2 of plate XII, and it, therefore, seems that the quantity of cement cannot be taken as a character of specific value, and all three specimens are consequently referred provisionally to one and the same species.

Limb-bones.—From the fertile fossil locality of Niki, in the Punjab, so frequently alluded to in previous pages, Mr. Theobald has obtained several portions of limb-bones of a large hippothere, probably belonging to the same individual as the upper and lower jaws. These remains comprise the upper portion of a tibia, the distal ends of a pair of radii, and a hind and fore-foot in a more or less complete state. I have nothing to note on the first three of these specimens, but have a few remarks to make regarding the feet, one of which is figured in plate XIII, figure 3, of this volume. This specimen belongs to the fore-limb, as is determined by its difference from another foot with a complete metatarsal. The distal extremity of the metacarpus is all that remains of that bone: the first and second medial phalanges are complete, but the terminal phalanx has been broken. On the right side are seen the three phalanges of one of the lateral digits, and on the opposite side the distal extremity of the lateral metacarpal. The central metacarpal bears flat facettes on its posterior aspect for articulation with the lateral bones. From the slenderness of the remaining lateral metacarpal it would seem that, as in *H. gracile*, these bones did not extend continuously along the whole length of the median metacarpal. The bones of this foot seem to be nearest in size to those of the stout variety of the Pikermi hippothere described by M. Gaudry.¹

In the specimen of the hind-foot in the Indian Museum, the lateral digits are smaller than in the figured specimen of the fore-foot.

Distinctness as a species and distribution.—The specimens examined above leave but little doubt as to the former existence of a second species of Siwalik hippothere, mainly distinguished from *H. antilopinum* by the difference in the

¹ "Animaux Fossiles et Géologie de l'Altique," pl. xxxv, fig. 13.

structure of its upper milk-molars, and by its generally larger size. The remains of this species are at present only known to me from the Siwaliks of the Punjab, and from Perim Island: from the latter locality certain upper molars, now in the Indian Museum, were catalogued by Dr. Falconer as belonging to *Equus*.¹ It is not impossible that the extremity of the mandible of an equine animal from Burma represented in figure 12 of plate LXXXII of the "Fauna Antiqua Sivalensis" may belong to the present species, as the Irawadi beds generally yield fossils of an old type. It is also possible that the fossil hippotherian teeth from China, referred to above, may belong to this species.

GENUS II: EQUUS, Linné.

Horses in which the feet are normally monodactyle and the anterior 'pillar' of the upper molars united throughout its length with the adjacent 'crescent.'

By many modern zoölogists the old genus *Equus* is subdivided into *Equus*, containing the horse only, and *Asinus*, containing all the other living members of the family; as, however, the distinctions between these two groups rest solely on external characters, they are manifestly inapplicable to any but the living species.

Species 1. EQUUS SIVALENSIS, Falc. and Caut.

Previous history.—With the exception of the notice of fossil Indian horses by the late Sir W. E. Baker already referred to, we have only the plates in the "Fauna Antiqua Sivalensis" to depend upon for the identification of this species. The specific name seems to have first appeared in that work. As it appears to me that the remains of two species have been figured in the "Fauna Antiqua Sivalensis" under the name of *E. sivalensis*, it is necessary to determine which specimens are to be considered as the type of that species. I have accordingly taken the skull represented in figures 1, 1a, 1b of plate LXXXI of that work as the type, since it is the most perfect specimen figured.

Upper molar series.—An inspection of the figures of the teeth in the above-mentioned type skull, or still better, of those of a cast of the same specimen, shows that the specimen bears the two last premolars and the three true molars. The teeth are very much worn, the first enamel island having totally disappeared in the penultimate premolar, and both these islands in the first true molar. The grinding surfaces of the molar series are characterised by the small size of the anterior 'pillar' in the premolars, the grinding surface of which is never larger than the same surface in the second true molar.

Another specimen of a much worn upper molar series, drawn in figure 3 of plate LXXXII of the same work, exhibits the same general dental characters.

In figure 2 of plate XIV of this volume is represented the complete left upper permanent molar dentition of the skull of a horse, collected by Mr. Theobald in the

¹ See "Pal. Mem.," Vol. I, page 188.

Siwaliks near the village of Pádri in the Punjab. The teeth of this specimen are in an intermediate condition of wear, and the first premolar (pm. 1) is seen to be persistent. These teeth agree with the specimens last noticed in the comparative shortness of the grinding surface of the anterior 'pillars' of the premolars, *i.e.*, they are not longer than the corresponding surface in the second true molar (m. 2); the specimen is accordingly referred to the present species.

In figure 1 of the same plate there are represented the five last teeth of the right upper molar series of a horse obtained by Mr. Theobald from the higher Siwaliks of the village of Rúpúr in the Punjab. These teeth are somewhat less worn than those of the previous specimen, and exhibit the characteristic shortness of the grinding surface of the anterior 'pillars' of the premolars, this being especially noticeable in this specimen, where this surface in the last premolar (pm. 4) is shorter than in the first true molar (m. 1).

The last specimen of the upper molar dentition of this species to be noticed is contained in a fragment of the right maxilla: another of Mr. Theobald's numerous Siwalik specimens (No. C 180, Ind. Mus.). In this specimen, which has not been figured, the four last teeth of the molar series are exhibited, the last true molar having only just come into wear: this specimen, therefore, belongs to a younger individual than either of the others. In it the length of the grinding surface of the anterior 'pillar' of the last premolar is considerably shorter than the corresponding surface of the first true molar, the respective lengths being 0·4 and 0·51 inch.

Taking, therefore, the five specimens above mentioned, which exhibit the teeth at all stages of wear, we find it to be a constant character of the upper molars of *Equus sivalensis* that the grinding surfaces of the anterior 'pillars' of the premolars are not longer than those of the later true molars, and are frequently shorter than the corresponding surface of the first true molar. The number of specimens examined, and their different ages, leave little doubt as to the trustworthiness of this character. It may be noticed that a considerable difference occurs in the size of the molars of the two specimens figured in this volume, but it does not appear to me that this can be considered as more than an individual or sexual character. In the only specimen exhibiting the complete molar series, the first premolar (milk-molar) is persistent, and of considerably larger size than the same tooth in living horses.

Comparison.—The difficulty of arriving at any satisfactory conclusion merely from a comparisons of the teeth of the horse-family is well instanced by the numerous so-called species which have been made from the European fossil remains of the domestic horse (*Equus caballus*). The teeth of many of the different living species are, indeed, so much alike that it would, I think, be impossible to distinguish many of them by the characters of the molar teeth alone. In the case of the fossil Siwalik horse, from the materials at my command, my comparisons must, perforce, be limited to the living Asiatic species.

In *Equus caballus* I cannot discover any instances where the anterior 'pillar' is as small as it frequently is in *Equus sivalensis*. In the former the second pre-

molar seems always to be worn very unequally, being more abraded in front than behind; in the latter the wear of this tooth is equable. In the former, again, the first milk-molar is of much smaller size than in the latter, and comparatively seldom persists. The larger form of *E. sivalensis* indicates an animal of, at least, fifteen 'hands' in height.

In *E. onager*, of north-western India and Persia, the anterior 'pillar' in all the molars is of large size, and is larger in the last premolar than in any of the true molars. The first milk-molar, if developed, seems to be always shed at a very early period.

In *Equus hemionus*, or the kiang, of Tibet, the upper molars in the matter of form are extremely close to those of *E. sivalensis*, and it seems to me that it is doubtful whether we could distinguish the molar series of the two forms if both were found in the fossil state. The molars of the living species do not, however, ever attain to the dimensions of the larger individuals of the fossil species. In the kiang, moreover, the first milk-molar is always very minute, and in all the skulls that have come under my observation is shed before any of the premolars appear. These, however, are but slight differences, and I cannot but think that there is a very intimate relationship between these two species, an inference which is supported by the characters of the crania of the two forms.

Cranium.—The specimens of the cranium which can with certainty be referred to this species are two, *viz.*, the one already referred to in the "Fauna Antiqua Sivalensis," and the one in the Indian Museum to which the molar dentition in figure 2 of plate XIV belongs. Both these specimens have lost their premaxillæ. A third skull of a Siwalik horse, in the Indian Museum, exhibits these bones, but, as all the molar teeth, except the two last, are wanting, I am not quite sure of the species to which that specimen belongs, though from the form of the skull I am inclined to refer it to *E. sivalensis*. The premaxillæ in that specimen are intermediate in length between those of the domestic horse and the kiang, but approach nearer to those of the latter, the interval separating the molar series from the incisors being very much less than in *Equus caballus*.

A specimen of the extremity of the premaxillæ of a Siwalik horse, of the species of which I am uncertain, in the Indian Museum¹ shows that the incisors are placed very obliquely. The specimen represented in figure 5 of plate LXXXII of the "Fauna Antiqua Sivalensis" exhibits the same character. This oblique position of the incisors is a character distinguishing *Equus caballus* from *E. onager* and *E. hemionus*. Unfortunately I am unable to say whether any of these specimens of the premaxillæ belong to *E. sivalensis* or to the next species.

The cranium of *E. sivalensis* figured in the "Fauna Antiqua Sivalensis" is of great breadth across the orbits, a character which it possesses in common with the

¹ No. C. 186. This specimen is described by Falconer on page 187 of vol. I of the "Palæontological Memoirs," No. 395, as the mandible

skull of *E. hemionus*. The relative proportions of the skulls of the above mentioned species may be estimated by taking the length of the molar series (inclusive of the persistent milk-molar) as unity, and seeing how many times this unit is contained in the interval separating the last true molar and the foramen magnum. This gives the following results:—

<i>E. onager</i>	. . . . .	= 1·07	1·07
" <i>hemionus</i>	. . . . .	= 1·15	1·15
" <i>sivalensis</i>	. . . . .	= 1·13	} average 1·145
" "	. . . . .	= 1·16	
" <i>caballus</i>	. . . . .	= 1·26	} " 1·305
" "	. . . . .	= 1·35	

A distinct trace of a 'larmial' cavity is observable in the skull of *E. sivalensis*, as was first pointed out by Professor Huxley in the passage already cited. No living horse shows any trace of such cavity, though it is well developed in the hippotheres.

The Siwalik skulls are not sufficiently perfect to admit of any closer comparison with those of living species; the points already observed, however, with the exception of the doubtful premaxillæ, certainly indicate a considerable resemblance between the crania of *E. sivalensis* and *E. hemionus*, coupled with the retention by the former of certain ancestral characters, which have been lost in the latter.

Mandible.—Two views of the greater portion of the horizontal ramus of the right side of the mandible of a Siwalik horse are given in the "Fauna Antiqua Sivalensis" (plates LXXXI, fig. 4; LXXXII, fig. 2)¹ under the name of *Equus sivalensis*. As similar jaws are not uncommon in the topmost Siwaliks, where *E. sivalensis* seems to be the commoner species, it is very probable that this reference is correct, though it cannot be considered as absolutely certain.

A very similar specimen, comprising the two rami, is in the collection of the Indian Museum (No. C.184), and was formerly in the collection of the Asiatic Society of Bengal; its description by Dr. Falconer is given in the "Palæontological Memoirs."² The two foregoing specimens show that the lower jaw of *E. sivalensis* is of great vertical depth, and that the 'diastema' is shorter than in the common horse, and thereby comes nearer the length of that of the kiang. The following table exhibits the chief dimensions of the two Siwalik jaws (*a*, British Museum, *b*, Indian Museum specimen) and the corresponding dimensions of the jaws of *E. caballus* and *E. hemionus*:—

	<i>E. cab.</i>	<i>E. siv.</i>		<i>E. hemi.</i>
		<i>a.</i>	<i>b.</i>	
Length of molar series	6·9	7·65	7·1	6·3
Depth " jaw behind last molars	4·35	4·9	5·1	3·7
" " behind last premolar	3·1	3·85	3·84	3·2
" " at commencement of diastema	2·2	2·85	2·8	2·15
Length " diastema	3·6	...	2·6	2·4

¹ In the description of the plates it is not mentioned that both figures are taken from the same specimen; the second figure is reversed.

² Vol. I, p. 186

These dimensions show that the relative proportions of the fossil jaw are nearer to those of the jaw of the kiang than to that of the horse. Unfortunately none of the specimens show the 'angle' of the mandible, in which there is such a marked difference in the two living species. The inferior border is arched, and very thick as in the kiang.

A symphysis of the mandible of a fossil horse in the Indian Museum, one of Mr. Theobald's Siwalik collection, shows that this portion of the jaw was elongated as in the living horse, and strikingly different from the corresponding part in the kiang. I cannot, however, say whether this specimen may not belong to *E. namadicus*; it agrees exactly in form with the symphysis of the mandible of *E. sivalensis* from the Siwaliks drawn in figure 6 of Plate LXXXII of the "Fauna Antiqua Sivalensis," but that reference may be incorrect.¹

Upper milk-molars.—In figure 1 of plate XV are represented the milk-molars of a young colt of a species of *Equus* from the Siwaliks. It is probable, from the evidence of a specimen of upper milk-molars from the Narbada to be described under the head of the next species, that the present specimen belongs to *E. sivalensis*. These teeth agree in general form with the milk-molars of the domestic horse, presenting the elongated form usually characteristic of the deciduous series. These teeth are contained in a fragment of the right maxilla, collected by Mr. Theobald; the portion containing the first milk-molar has been broken away.

Other remains.—The Indian Museum possesses a considerable series of limb-bones of true horses from the Siwaliks. It is not, however, possible to be certain as to the species to which these should be referred, and accordingly only such of them will be noticed as bear on the question of the reputed monodactyle character of *Hippotherium antilopinum*.

Cannon and phalangeal bones.—There are a considerable series of 'cannon' and phalangeal bones in the Indian Museum, obtained by Mr. Theobald from the upper Siwaliks of the Kangra district, in company with the teeth of *Equus sivalensis*, which may probably be referred to that species, and certainly to the genus *Equus*, as the remains of *Hippotherium* have not been obtained from these higher beds. These bones are of a slender type, and many of them agree with the 'cannon' and phalangeal bones figured in the "Fauna Antiqua Sivalensis" as belonging to *H. antilopinum*.²

It may be noticed in passing that the last mentioned specimens are, as already said, those on the evidence of which M. Gaudry stated that *H. antilopinum* was unprovided with lateral phalanges. There is little, if any, doubt but that these bones belong to *Equus*. No hippotherium has the first phalangeal bone so constricted.

Other corresponding bones are figured in the same plate of the "Fauna

¹ In the description of the plate the specimen is erroneously said to belong to the maxilla.

² Pl. LXXXV, figs. 11 to 14.

Antiqua Sivalensis" under the name of *Equus sivalensis*,¹ but of somewhat larger size. It is not impossible that these two types of bones may belong to the two species of Siwalik horses, or it is possible they may be merely sexual differences, as we have noticed considerable variations in the size of the teeth referred to *E. sivalensis*.

The proximal phalangeal bones are much compressed in the middle, and are of an elongated type, in both of which respects they resemble the phalangeals of *Equus hemionus*, and the zebras, and differ from the corresponding bones in the true horses.* All the evidence seems, therefore, to connect *E. sivalensis* with the asses and zebras, rather than with the domestic horse.

General character of species.—Judging by the remains above enumerated, which can certainly be referred to the present species, it would seem that *E. sivalensis* was most nearly allied to the Tibetan kiang, but that in its retention of a 'larmial' cavity and of the relatively large persistent first upper milk-molar, and in the small size of the grinding surfaces of the anterior 'pillars,' it retained characters connecting it with the ancestral genus *Hippotherium*. If certain remains belong to this species, in the inclination of its upper incisors and the form of the symphysis of the mandible it more nearly approached the horse; this is, however, doubtful. On the whole, I think it not improbable that this species may have been the ancestor of the living kiang of Tibet.

Distribution.—Remains of *E. sivalensis* have been hitherto obtained only from the higher beds of the sub-Himalayan Siwaliks to the eastward of the river Jhelum.

SPECIES, 2 *EQUUS NAMADICUS*, Falc. and Cant..

Synonym *E. palæonius*, F. and C.

History.—In plates LXXXI and LXXXII of the "Fauna Antiqua Sivalensis" are represented certain specimens of the cranium, teeth, and jaws of fossil horses under the names of *E. namadicus* and *E. palæonius* from the pleistocene deposits of the Narbada valley. It has already been stated that these remains in all probability belong to the same species, and they will be so considered here. There are no means of knowing on what grounds the authors of the above-quoted work distinguished the Narbada from the Siwalik horse, and it is possible that the distinction was made merely on the grounds of the different formations whence the specimens were obtained. In the following descriptions certain molar teeth from the Siwaliks will be noticed differing from those we have referred to *E. sivalensis*, and, as far as can be determined with the materials at command, apparently agreeing with the molars of the fossil horse from the Narbada beds. There is, however, as already said, always very considerable difficulty in determining the species

¹ Figs. 7, 8.

² See, De Blainville's "Ostéographie" 'Equus,' pl. V.

of horses by means of the molar series alone, and there is consequently a certain possible element of doubt in the following determinations.

Upper molars.—In figure 3 of plate XV of this memoir are represented the earlier molar teeth of a true horse from the Narbada bone-beds, collected several years ago by Mr. Haekel of the Geological Survey. These teeth are implanted in a fragment of the left maxilla. At the anterior end of the series is seen the broken base of the first premolar, or persistent milk-molar (pm. 1), followed by the remaining three premolars (pm. 2 to pm. 4), while the last complete tooth is the first true molar (m. 1). The anterior teeth are determined to be premolars from the fact of the last of them (pm. 4), being less worn than the succeeding tooth (m. 1).

A comparison of these teeth with the upper molars of *E. namadicus* represented in plate LXXXII, figure 7 of the "Fauna Antiqua Sivalensis," will leave little doubt but that the two belong to the same species. They differ from the corresponding teeth of *E. sivalensis* by the larger size of the anterior 'pillar' in the last premolar.

Sivalik specimens.—In figure 3 of plate XIV of this memoir there is represented the left maxilla of a horse, collected by Mr. Theobald in the topmost Siwaliks of the Hushiārpūr district of the Punjab, exhibiting all the teeth of the molar series with the exception of the first premolar, or milk-molar (pm. 1), of which only the broken base remains. These teeth belong to the permanent series, and are in an intermediate condition of wear: an inspection of the figure will at once show that they differ very markedly from the molars of *E. sivalensis* represented in figure 2 of the same plate. This difference mainly consists in the greater length of the grinding surfaces of the anterior 'pillars' of the last two premolars (pm. 3, pm. 4), which exceeds the length of any of the corresponding surfaces in the true molars. All the anterior 'pillars' are, indeed, very much larger than those of the molar series of *E. sivalensis*.

The great difference in the form of the anterior 'pillars' of these teeth from those of the molars of *E. sivalensis* figured in the same plate, appears to leave little doubt but that they belong to another species. Comparing them with the teeth of *E. namadicus* from the Narbada, noticed above, the two series are seen to agree very closely in the great relative size of the anterior 'pillar' of the last premolar, though in the Siwalik specimen the same 'pillar' in the penultimate premolar (pm. 3) is equally well developed. Both specimens, however, agree in the relatively large size of the grinding surfaces of the anterior 'pillars,' especially in the premolars, and I think it not impossible that the two may belong to the same species. This inference is confirmed by a specimen of the right maxilla of a horse represented in figure 4 of plate XV, and collected by Mr. Theobald in the Siwaliks of the Punjab, which seems to be intermediate between the two specimens above described.

The specimen of a right maxilla of a horse from the Siwaliks, represented in

plate LXXXII, figure 1 of the "Fauna Antiqua Sivalensis," under the name of *E. sivalensis*, appears to agree with the last mentioned specimen.

Finally, taking the Narbada specimen as the type of the teeth of *E. namadicus*, it seems highly probable that the specimen represented in plate XV, figure 4, belongs to the same species, and this being so, it is difficult to separate the specimen represented in plate XIV, figure 3, which certainly does not belong to *E. sivalensis*, and if not referred to *E. namadicus* must belong to a new species.

Upper milk-molars.—If the permanent molars described above have left any doubt as to there being two species of fossil Indian true horses, this doubt is at once dispelled if the upper milk-molars of a horse from the Narbada represented in figure 2 of plate XV are compared with the corresponding teeth from the Siwaliks represented in figure 1 of the same plate. These teeth are implanted in a fragment of a right maxilla, collected by Mr. Hackett in the pleistocene deposits of the Narbada valley. At the right side of the figure is seen the small first milk-molar (mm. 1), immediately behind which a fragment of the second milk-molar (mm. 2), and the germ of the displacing second premolar can be seen; the two next teeth (mm. 3, mm. 4) are the third and fourth milk-molars, as is proved by their state of wear, and by the germs of replacing premolars below them; while the last tooth (m. 1) is the first true molar.

By comparing these teeth with the upper milk-molars represented in figure 1 of the same plate, and referred to *E. sivalensis*, the essential difference between the two will be at once apparent. The present milk-molars differ indeed from those of any species of true horse with which I am acquainted by the nearly square form of their grinding surfaces, and thereby approach the milk-molars of some of the hippotheres, like *H. antilopinum*.

As no other species of horse, besides *E. namadicus*, is known from the Narbada these teeth are provisionally referred to that species: taken with the Siwalik milk-molars they unquestionably prove the existence of two species of fossil Indian horses.

Comparisons.—Assuming that all the specimens described above belong to *E. namadicus*, we may predicate of that species that the upper molars are distinguished by the relatively great length of the grinding surfaces of the anterior 'pillars,' a character especially well-marked in the premolars, but that there is a certain amount of variability in this character. The species is further distinguished from all living horses by the square form of the crowns of the upper milk-molars; and is also marked by the very general retention of the first milk-molar in the permanent series, though, judging from the specimens figured in the "Fauna Antiqua Sivalensis," this character is not always noticeable; when present the persistent first milk-molar is always of much larger size than in existing horses.

In *Equus caballus* the grinding surfaces of the anterior 'pillars' of the upper true molars are about equal in size to those of *E. namadicus*. In the premolars they are, however, smaller. The enamel islands in the existing horse

generally exhibit less plication of their borders, and the first milk-molar, if present, is always smaller than in *E. namadicus*.

In *E. hemionus* the grinding surfaces of the anterior 'pillars' of the upper molars are of comparatively small size, and the first milk-molar is always shed at an early period.

In *E. onager* the anterior 'pillars' of the upper molar series present a close resemblance to those of *E. namadicus*, their grinding surfaces being long, and that surface in the last premolar being longer than in any other tooth. In the recent species, however, the central enamel islands have their borders less plicated than in the fossil, and the small first milk-molar disappears at an early age.

I am unable to make any comparisons between the teeth of *E. namadicus* and those of the living African *Equidæ*, and I cannot identify them with any of the fossil European or American forms.

Skull.—From a cast of the incomplete skull figured in plate LXXXI, figures 5 and 6, of the "Fauna Antiqua Sivalensis," the only comparison that I can make is that the skull belongs to the elongated type of that of the common horse, the relative length of the molar series to that of the interval between the last true molar and the foramen magnum being 1 to 1·28. This shows that in respect to the skull, *E. namadicus* is more nearly related to the horse than to the wild asses of Asia (see above, p. 24).

Mandible.—In the "Fauna Antiqua Sivalensis" (plate LXXXI, fig. 7) a lower jaw of a fossil horse from the Narbada, referred to *E. namadicus*, seems to be indistinguishable from that referred to *E. sivalensis*. This opens up the question whether the jaw referred to the latter is correctly determined, and whether it may not really belong to *E. namadicus*; on the other hand, it is quite likely that *E. sivalensis* may occur in the Narbada. As there seems at present no means of settling this question, I have adopted provisionally Falconer's determination of the mandible of *E. sivalensis*, and shall merely refer here to another form of mandible from the Siwaliks, which may belong to *E. namadicus*. The teeth of the specimen in question are represented in figure 5 of plate XII of this volume; they comprise the three true molars. The specimen consists of a portion of the right ramus of the mandible, and was obtained by the late Conductor J. Dawe, from the Siwaliks in the neighbourhood of Nahan; it was referred by Dr. Falconer to *E. sivalensis*. The elongated teeth and the bold loops of the enamel render it probable that the specimen belongs to *Equus*. The jaw is more slender than the specimen figured in the "Fauna Antiqua Sivalensis" as the mandible of *Equus sivalensis*, and yet the teeth are of absolutely larger size, indicating the probability of the specific distinctness of the two specimens. It would be unsafe to make any more precise attempt at the specific identification of the present specimen.

Other remains.—In figures 9, 10, 11 of plate LXXXII of the "Fauna Anti-

¹ See "Pal. Mem." Vol. I, p. 187 (No. 307).

qua Sivalensis," there are represented the anterior extremities of the skull and mandible, and the lower milk-molar dentition of a fossil horse from the Narbada, under the name of *Equus palaeonius*. As the corresponding parts of the skeleton of *E. namadicus* are not represented in the "Fauna Antiqua Sivalensis," it is now impossible to understand what could have induced the authors of that work to separate these remains from *E. namadicus*. Until, therefore, any evidence which should lead to the adoption of a contrary view be produced, these remains are, following the suggestion of the late M. Lartet, referred to that species. The name of *E. palaeonius* must consequently be abolished. The remains above noticed do not present any characters requiring special notice.

Distribution.—Remains of *E. namadicus* have been obtained from the pleistocene beds of the Narbada, and if the above determinations be correct, from the topmost Siwaliks, in company with *Bubalus palaeindicus* and *Camelus sivalensis*, in beds which are probably high up in the pliocene series, if, indeed, they also do not belong to the pleistocene. Remains of a fossil horse have been obtained from the older alluvium of the Jamna valley, very possibly belonging to the present species, though this cannot be certainly determined.

If it should turn out that the identification of the second species of Siwalik horse with *E. namadicus* be incorrect, the former remains will have to be referred to a new species.

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- "Beiträge zur Kenntniss der fossilen Pferde, &c.," 'Verhand. d. natfor. Gesel. in Basle,' Vol. III, No. 4.
- "Weitere Beiträge zur Beurtheilung der Pferde der Quaternar—Epoche." 'Abhand. d. Schweiz. pal. Gesel.' 1875.

NOTE.

For the American species the numerous memoirs of Messrs. E. D. Cope, J. Leidy, and O. C. Marsh, in the publications of the American Surveys, and in the "American Journal of Science and Art," have been consulted, but are not quoted at length, as the species described do not approach the Indian forms. A recent memoir by Veterinary Surgeon Thomas, of the French Cavalry, entitled "Recherches sur Équidés fossiles des environs de Constantine,"¹ is not procurable in India, and may contain species not mentioned in my list. The second part of Professor Forsyth Major's memoir only reached India while the above was passing through the press, and the new species therein mentioned is therefore, only incidentally referred to.

¹ 'Bul. Soc. d. Sci. phys. et Nat. d' Alger,' 1879.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK CAMELOPARDALIDÆ.

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

[WITH PLATES XVI TO XXII.]

Order: UNGULATA, Div. ARTIODACTYLA.

Family: *CAMELOPARDALIDÆ*.

Terms employed in description of molars.—In describing the upper molars of ruminant Artiodactyla in this and succeeding parts of the present work, the following terms will be employed, viz.:—

Anterior lobe=Antero-external column of crown (Pl. XVI, fig. 7—*a*).

Posterior „ =Postero „ „ „ (*ibid* *c*).

Anterior crescent=Antero-internal „ „ (*ibid* *b*).

Posterior „ =Postero „ „ „ (*ibid* *d*).

Accessory tubercle=Tubercle between the two *crescents*.

Dorsum=External surface of tooth.

Costæ=Ridges on *dorsum*.

Cingulum=Belt surrounding base of crown.

Enamel pits or islands=Spaces enclosed by folds of enamel between the *lobe* and *crescent* of each division of the crown.

Median valley=The space separating the two *crescents* internally.

In the lower molars the same terms will be employed, with the exception, that from the fact of these teeth being the reverse of the upper ones, the ‘*crescents*’ will be on the outer, and the ‘*lobes*’ on the inner sides of the teeth. In the last lower tooth of both the deciduous and the permanent series, the additional division will be termed the third or accessory column; this may contain both a ‘*lobe*’ and a ‘*crescent*,’ or may consist of the latter only.

Definition of Camelopardalidæ.—The family *Camelopardalidæ* is represented at the present day by the single genus *Camelopardalis*, and that genus only by the giraffe or camelopard (*C. giraffa*) of Southern Africa. In past geological periods, however, the genus was represented by several species, which once inhabited the European and Asiatic continents, and from which the African form may have taken

its origin. The solitary living representative of this peculiar family is one of the most highly specialised and abnormal of existing ruminants, and, according to Professor Owen¹, "is in some respects intermediate between the 'hollow-horned' [as represented by the Antelopes] and 'solid-horned' ruminants, though partaking more of the nature of the deer." Professor Murie² observes that "the giraffe is but a modified deer," and this kinship is especially marked in the structure of the molar teeth, which approximates to that of certain members of the deer family, such as the true elk (*Alces*) and the so-called Irish elk (*Megaceros*). The so-called horns of the giraffe, moreover, approach nearer in structure to the antlers of the deer (*e. g.* the pedicles of the antlers of the mantjac) than to the horns of the antelopes. In the structure of its intestines, and the normal absence of the gall-bladder, the giraffe resembles the deer, but the occasional development of the latter appendage recalls antelopeine affinities. In some respects, as in the form of the 'angle' of the mandible, the giraffe decidedly shows a nearer approach to the antelopes than to the deer. The lachrymal vacuity in the skull is a cervine character.

Although palæontologists have described several fossil representatives of the genus *Camelopardalis*, they have not hitherto decidedly admitted into the family any other genus with the exception of *Qrasius* of Wagner, founded upon certain molar teeth of a giraffe-like animal from the ossiferous deposits of Pikermi. These teeth³ are distinguished from those of *Camelopardalis* by the presence of a distinct 'cingulum,' and by the more complex form of the last true molar.

M. Gaudry, however, has indicated⁴ the near affinity of the genus *Helladotherium* of the Pikermi beds to the giraffe, the former having been originally referred to the same genus.

In the course of the present memoir it will be shown that some of the large fossil ruminants from the Siwaliks present characters allying them on the one hand with *Sivatherium*, which Professor Murie⁵ has made the type of the family Sivatheridae, and on the other with the giraffe, and that they so completely bridge over the gulf existing between these two animals that it appears to the author to be necessary to include them all in one family,—the *Camelopardalidæ*,—having the giraffe at one end and the sivathere at the other⁶. In the course of this memoir it will be shown that the whole of the family is probably more closely allied to the deer than to any other group of mammals. This view is in opposition to that of Dr. Murie, who was inclined to separate the sivathere entirely from the giraffe, and to connect it with the prongbuck (*Antilocapra*) and the saiga antelope.

¹ "Anatomy of Vertebrates," Vol. II, pp. 463-464.

² "Geological Mag.," Vol. VIII, p. 446.

³ Wagner, "Nachträge zur Kenntniss der fossilen Hufthier Ueberreste von Pikermi." (Sitz. d. k. bair. Akad. d. Wissens., July 13th 1861). I have no doubt that the lower molars figured by Wagner as belonging to an animal allied to the giraffe are really the lower molars of his genus *Qrasius*.

⁴ *Animaux Fossiles et Géologie de l'Attique*, p. 259.

⁵ "Geol. Mag.," Vol. VIII, p. 438 *et seq.*

⁶ A notice of the intimate relationship of the above-mentioned animal was published by the author in 1882. (R. G. S. I., Vol. XV, p. 30.)

Genera of Camelopardalidæ.—The family Camelopardalidæ, as thus extended, will include the following seven genera, which are placed, as far as this can be determined from the materials available, in the order of their relationship to one another, indicating a gradual diminution in the length of the limbs and of the neck from the giraffe to the sivathere :—

CAMELOPARDALIS, Linné.—India, Africa, and Europe.

ORASIUS, Wagner.—Europe.

VISHNUTHERIUM, Lydekker.—India.

HELLADOTHERIUM, Gaudry.—Europe and India.

HYDASPITHERIUM, Lydekker.—India.

BRAMATHERIUM, Falconer.—India.

SIVATHERIUM, Falc. and Caut.—India.

In this list *Orasius* is placed next to *Camelopardalis* solely on the evidence of its molar teeth, its limbs and skull being still unknown; its position may, therefore, have to be changed. The place of *Vishnutherium* is decided from the evidence of limb-bones provisionally assigned to it. *Helladotherium*, of which almost the entire skeleton is known, is placed above *Hydaspitherium*, because the hornless cranium allies it more nearly with the giraffe than with the sivathere; its limbs, however, seem to have been shorter than those of the latter genus, from which evidence it should be placed nearer the sivathere. This discrepancy shows that a strictly lineal arrangement of the genera is impracticable. The three last genera are associated on account of the complex structure of their horns; the limbs of the first and second are longer than those of the third.

The whole of the family is confined to the old world¹.

Characters of family.—The family Camelopardalidæ, as thus extended, will embrace a group of animals characterised by the highly reticulate or rugose structure of the enamel of their molar teeth, and by the general similarity in the structure of these teeth. They may be completely unprovided with horns or (?) antlers (*Helladotherium*), or these appendages may be more complex than in any living ruminant (*Bramatherium* and *Sivatherium*). The horns of the giraffe, the one living member of the group, are permanently enveloped by the skin, and, as already said, seem to have more relationship with the antlers of the deer than with the horn-cores of the cavicorn ruminants. The structure of the horns of the fossil forms is unknown; but as these horns do not show a 'burr' like the antlers of the deer, they were almost certainly persistent, and were perhaps covered with a deciduous horny sheath. In length of limb these animals ranged from the proportion prevailing among the oxen to that of their most specialised member, the giraffe.

The grouping of the above-mentioned genera in a single family and in serial order is not meant to indicate that one genus is the descendant of the other, but

¹ *Megacerops* of the American tertiaries was formerly described as an ally of the Sivatherium by Prof. Cope ("Pro. Acad. Nat. Sci. Phil.," January 3rd, 1870), and as such quoted by Dr. Murie in his memoir on *Sivatherium* (Geol. Mag., Vol. VIII). Dr. Leidy ("Contributions to Extinct Vert. Fauna of Western Territories," p. 239) showed that the genus belonged to the order Dinocerata of Marsh.

merely that their relationship is so close as to indicate blood affinity. As the long-limbed Siwalik giraffe lived contemporaneously with the short-limbed sivathere, it is evident that the evolution of the long-limbed member had taken place long previously to pliocene times; and the genera with limbs of intermediate length merely indicate that they are survivors from those animals which formed the chain connecting in a direct line the giraffe with its unknown short-limbed ancestor.

Object of memoir.—In the following pages a considerable series of hitherto undescribed remains belonging to several of the above-mentioned genera will be noticed more or less fully, and the leading characters, as far as they are known, of the Indian genera will be touched upon. In treating of each genus, the bones of the lower part of the limbs and more especially the 'canon-bones' will be taken as a guide in the estimation of the proportions of the limbs of their owners. The genera will be discussed in the order in which they are arranged above. The present memoir is not intended as a description of all that is known regarding the osteology of the fossil members of this family, on which subject numerous memoirs have already appeared. It is rather intended to illustrate the relationship of the different members to one another, and the position of the family in the mammalian class. For details the reader is referred to the memoirs previously published to which references are abundantly given.

GENUS I: CAMELOPARDALIS, Linné.

Number of species.—The following list gives the number of named species belonging to this genus, and their distribution:—

1. CAMELOPARDALIS ATTICA, Gaudry and Lartet, Europe; (?) miocene.
2. CAMELOPARDALIS BITURIGUM¹, Duvernoy, Europe; miocene.
3. CAMELOPARDALIS GIRAFFA, Linné, South Africa; recent.
4. CAMELOPARADLIS SIVALENSIS, Falc. and Caut., India; pliocene.
(*C. affinis*, Falc. and Caut.)
5. CAMELOPARDALIS VETUSTA, Wagner, Europe; (?) miocene.

The so-called *Camelopardalis duvernoyi* (Gaudry and Lartet) belongs to *Helladotherium*; and *Camelopardalis eximia* of Wagner is the same as *Orasius eximius*².

Characters of molars.—According to Professor Owen³, the characteristic points of the upper molars of the genus *Camelopardalis* are as follows: the median 'costa' of the 'dorsum' of the anterior 'lobe' is more prominent than any other part of that surface, while in the posterior 'lobe' the anterior 'costa' is more prominent than the median. The enamel pits penetrate deeply into the crown, and are not completely separated from one another until a late period of detrition. The 'accessory tubercle' is reduced to a very small basal rudiment, and the enamel is unusually rugose. No

¹ P = *Helladotherium* (Owen, "Paleontology," 2nd Ed., p. 409).

² Apparently by an error, M. Gaudry ("Animaux Fossiles et Géologie de l'Attique," page 250) quotes this species as *Camelopardalis (Orasius) speciosa*.

³ "Odontography," p. 534.

'cingulum' is present. In the lower molars the first true molar is very generally distinguished by the presence of a large 'accessory tubercle,' and in the third the 'accessory column' is of large size, shows a distinct median island, and a consequent division into an inner and an outer moiety. The 'lobes' are placed obliquely to the long axis of the crown.

Species : *CAMELOPARDALIS SIVALENSIS*, *Falc. and Caut.*

Syn. *C. AFFINIS*, *Falc. and Caut.*

History and previous notices.—The first notice of the occurrence of a fossil giraffe in the Siwaliks was made by the late Sir (then Captain) P. T. Cautley, in a note communicated to the Asiatic Society of Bengal¹, in 1838, in which a cervical vertebra and certain molar teeth were noticed, and considered to belong in all probability to a species of giraffe. At a later period a joint notice of these and other remains of giraffes was communicated by Messrs. Falconer and Cautley to the Geological Society of London, and an abstract of the same, with illustrations published in the 'Proceedings' of that Society for 1843². This abstract and plate are copied in the "Palæontological Memoirs"³. In that paper the authors came to the conclusion that the third cervical vertebra belonged to an animal one-third smaller than the living giraffe, to which they assigned the name of *Camelopardalis sivalensis*, while the molars belong to a species equalling in size the living species, to which they assigned the provisional name *C. affinis*. In 1845 Dr. Falconer contributed a notice to the Geological Society⁴, in which a second specimen of a cervical vertebra of a fossil giraffe was described, and referred to *C. sivalensis*, from its agreeing in size with the Siwalik specimen. In 1859 Dr. Falconer described⁵ two lower jaws of a ruminant in the collection of the Asiatic Society of Bengal as probably belonging to *Camelopardalis sivalensis*. In the same catalogue two limb-bones were referred to the same species, one of which (radius) is said to have equalled in size the corresponding bone of the living giraffe.

In 1862 M. Gaudry⁶ made a few remarks on the Indian fossil remains of *Camelopardalis*.

In 1865 two lower ruminant molars, collected by the Messrs. Schlagintweit in the Siwaliks, near Narpur in the Punjab, were described and figured by the late H. Von Meyer⁷, who doubtfully referred them to *Camelopardalis*, without attempting to determine their species.

In 1868, after the death of Dr. Falconer, the description of plate E. of the "Fauna Antiqua Sivalensis" (an autotype copy of which is now obtainable in London) appeared, compiled from Dr. Falconer's notes. In this description

¹ "J. A. S. B.," Vol. 7, p. 658.

² No. 98.

³ Vol. I, p. 190, pl. XVI.

⁴ "Q. J. G. S.," Vol. I, p. 356; and "Pal. Mem.," Vol. I, p. 391.

⁵ "Cat. Foss. Vert. Mus. A. S. B.;" and "Pal. Mem.," Vol. I, p. 206.

⁶ *Loc. cit.*, p. 250.

⁷ "Palæontographica," Vol. XV, p. 29, figs. 1-5.

the whole of the specimens figured are classed under the head of *Camelopardalis sivalensis*. The specimens comprise the original type Siwalik cervical vertebra (fig. 1); another cervical vertebra from Perim already noticed (fig. 2); and a so-called first cervical vertebra¹ from the Siwaliks (fig. 11), apparently of much larger dimensions, and seemingly as large as the corresponding bone of *Camelopardalis giraffa*.

The nomenclature of this large specimen, as well as of some large limb-bones figured in the same plate, is a somewhat noteworthy point, as it would lead to the inference that the authors of the "Fauna Antiqua Sivalensis" had by this time abandoned their distinction between *Camelopardalis sivalensis* and *C. affinis*.

In 1876 a notice appeared by myself² in which it was concluded that there was only evidence of one species of Siwalik giraffe which should be termed *C. sivalensis*. In that notice a comparison was made between the dimensions of the Siwalik cervical vertebra and that of a living giraffe, both measurements being given by Messrs. Falconer and Cautley. Unfortunately it had not been observed that the vertebra of the living species was stated to have belonged to a small and not fully developed individual; the comparisons, therefore, fall to the ground, and hence, apparently, the conclusions regarding the identity of the two Siwalik species. It will, however, be shown subsequently that on other grounds this conclusion must probably be maintained. In the course of the above-quoted notice, it was shown that the teeth in the collection of the Asiatic Society of Bengal, and now in the Indian Museum, doubtfully referred by Dr. Falconer to *Camelopardalis sivalensis*, really belong to some totally different genus.

Later on in the same year, a portion of the right ramus of the mandible, with the last premolar and the first and second true molars, of a Siwalik giraffe was described and figured by myself³ under the name of *C. sivalensis*. This jaw and teeth were shown to be of considerably larger dimensions than the corresponding parts of the skull of *C. giraffa* with which they were compared, and the fossil premolar was shown to be distinguished by its more elongated form from the recent tooth.

In 1878 several teeth and jaws of giraffes and giraffe-like animals were described at some length by myself⁴ in a paper which will be frequently quoted in the course of this memoir. In that notice it was concluded that there was probable evidence of the existence of three species of Siwalik giraffes. Subsequently acquired specimens have, however, rendered it probable that two of these species must be merged in one, while the third probably belongs to another genus.

The above comprehend the previous notices of this species of any importance, and we may now proceed to the description of the specimens forming the subject of this memoir.

¹ It would appear from this specimen, which is certainly not an 'atlas' vertebra, that Falconer's numbering of the cervical vertebrae, comprehends only the vertebrae behind the axis; hence the vertebra called by him the first is really the third, and so on.

² "R. G. S. I.," Vol. IX, p. 104.

³ *Supra*, Vol. I., p. 58, pl. VII, figs. 14, 15.

R. G. S. I., Vol. XI, p. 83.

Upper molars.—In figures 1 and 2 of plate XVI of the present memoir are represented specimens of the third and fourth upper premolars¹ and of the three true molars of a fossil giraffe, collected by Mr. Theobald in the Siwaliks of the Punjab. These teeth are contained in two fragments of the maxilla of opposite sides, and belonged to the same individual. It is probable that the whole skull was imbedded in the sandstone from which the teeth were obtained, and was broken up by the villagers who brought the teeth to Mr. Theobald, since the mandible represented in figure 5 of the same plate almost certainly belonged to the same animal, though obtained a year later. The upper molars are those already described in the notice in the eleventh volume of the "Records"², the greater part of which is repeated here.

The two last teeth in figure 2 (m. 2, m. 3) agree precisely (allowing for the difference in wear) with the two corresponding teeth figured by Messrs. Falconer and Cautley under the name of *Camelopardalis affinis*³, and undoubtedly belong to the same species. As we shall show subsequently that that species cannot be separated from *Camelopardalis sivalensis* (the first-named species), we refer the original specimens, and others like them, to the latter species. The general form of the figured teeth is so close to that of the teeth of the living species that, as stated by Messrs. Falconer and Cautley, it requires the aid of the callipers to distinguish them. In the following table the dimensions of Mr. Theobald's specimens are given in the first column, while in the second are given those of the specimens described in Messrs. Falconer and Cautley's memoir⁴, and in the third column are given the corresponding dimensions of the molars of an adult skull of *Camelopardalis giraffa*, of unknown sex, in the collection of the Indian Museum. The dimensions given in the fourth column are those given by Messrs. Falconer and Cautley, taken from an adult female skull of the same species in the Museum of the Royal College of Surgeons.

	C. SIVALENSIS.		C. GIRAFFA.	
	Mr. Theobald's specimen.	Falconer and Cautley's specimens.	Indian Museum specimens.	College of Surgeons specimen ♀.
Length of penultimate premolar	0·8	1·08	1·08	0·95
Width of " "	0·98	1·22	1·22	1·12
Length of last " "	0·98	...	0·9	...
Width of " "	1·06	...	1·1	...
Length of first true molar	1·07	...	1·1	...
Width of " "	1·1	...	1·2	...
Length of second " "	1·19	...	1·21	...
Width of " "	1·35	1·45	1·35	1·35
Length of third " "	1·27	1·2	1·21	...
Width of " "	1·25	1·4	1·3	1·3
Length of second and third true molars	2·4	2·5	2·55	2·55

¹ In this memoir the premolar teeth of ruminants will be numbered according to those of the typical series, though the first tooth is never developed.

² Pages 84-5.

³ "Pal. Mem." Vol. I, pl. XVI, figs. 5, 5a.

⁴ *Loc. cit.*, pp. 202-3.

This table shows that while Falconer and Cautley's specimens are slightly larger than those of the living species, Mr. Theobald's specimens are slightly smaller, thus indicating a certain amount of variation in the size of the upper molars. It further shows that in the two specimens (one recent, and the other fossil), in which the whole premolar and molar series is exhibited, the fossil form is distinguished by the penultimate being larger than the last premolar, the reverse of this arrangement obtaining in the recent form.

In describing their specimens, Messrs. Falconer and Cautley notice the presence of three small tubercles on the inner surface of two specimens of the penultimate upper premolar, which were wanting in the corresponding tooth of the recent skull examined by them. The recent skull in the Indian Museum likewise shows the absence of these tubercles. In my first description of the specimens figured in this memoir these tubercles were likewise stated to be absent, but a more thorough cleansing of the specimen has shown that one broad and flat tubercle exists on the hinder half of the inner aspect, probably corresponding with the two posterior tubercles on the original specimen. As far, therefore, as the materials at hand go, the presence of tubercles on the inner aspect of the penultimate upper premolar does seem characteristic of the fossil teeth. None of the figured specimens show any trace of the minute tubercle at the entrance of the median valley so generally occurring in the upper molars of the living species. Some of Messrs. Falconer and Cautley's specimens and others in the Indian Museum do, however, present this tubercle. Some specimens of the last true molar show a rudimentary 'cingulum' on their anterior face.

Two other specimens of upper molars of Siwalik giraffes, from among Mr. Theobald's Siwalik collection, call for a moment's notice. One of these specimens (No. B. 180) is a portion of the right maxilla, showing the first and second true molars, the first being only just touched by wear. These specimens cannot be distinguished from the figured teeth, except by the presence of a small process projecting from the posterior 'crescent' into the central pit. A last upper molar (B. 346), however, agreeing precisely in all other respects with the corresponding tooth represented in figure 2 (m. 3), presents a similar process, so that it would seem that the presence or absence of this process, like the tubercle in the median valley, can only be reckoned as an individual character.

The other specimen also consists of a fragment of the right maxilla (No. B. 177), and shows the penultimate and last premolars, and the first true molar. The latter tooth agrees precisely with the first true molar in No. B. 180 even down to the presence of the process in the posterior pit, but is distinguished by the presence of a tubercle in the median valley. The dimensions of the three teeth above mentioned are given below :—

	No. B. 180.	No. B. 170.
Length of first true molar	1.15	1.12
Width " "	1.14	1.11
Length of second "	1.3	
Width " "	1.3	

Taking all the teeth noticed above together, it is apparent that there is a certain amount of variability in the matter both of size and structure in the upper molars of the Sivalik giraffe, and that as a series they are, as remarked by Messrs. Falconer and Cautley, "all but indistinguishable from those of the Nubian giraffe;" and if we had no remains but the upper molar teeth, it is very doubtful whether any distinction could be drawn between the living and the fossil forms.

Mandible and lower molars.—In Messrs. Falconer and Cautley's original notice, the described teeth of the lower jaw were a last lower molar of the left side¹, and the last premolar of the same side². The specimen described by myself in the first volume of this series³ showed the last premolar and the first and second true molars. In my notice in the "Records"⁴ two specimens of the last lower molar were noticed and considered to belong to distinct species. Since that notice was written the right ramus of the mandible represented in figure 5 of plate XVI of this memoir has been obtained by Mr. Theobald⁵, and seems to invalidate the distinctions drawn between the foregoing specimens; an inference confirmed by another specimen of the last lower molar lately acquired by the Indian Museum. We thus now have six specimens of the mandible of Siwalik giraffes, showing among them five specimens of the last lower true molar, and two specimens of both the second and first true molars and of the last premolar. In the following table the dimensions of all these five specimens, together with the corresponding dimensions of the mandible of the living giraffe, are given; the specimens in the Indian Museum are indicated by their respective numbers in the catalogue.

	B. 179 (pl. XVI, fig. 6).	B. 179A.	B. 178.	Falconer's specimens.	B. 179 (pl. XVI, fig. 5).	Living Giraffe.	B. 1 (Vol. I, pl. VII, figs. 14, 15).
Length of last premolar . . . . .	...	...	...	1.0	1.0	0.9	1.15
Width " " " . . . . .	...	...	...	0.86	6.2	0.8	0.9
Length " first true molar . . . . .	...	...	...	...	1.11	1.0	1.3
Width " " " " " . . . . .	...	...	...	...	0.86	0.9	1.0
Length " second " " " . . . . .	...	...	1.1	...	...	1.15	1.25
Width " " " " " . . . . .	...	...	0.9	...	...	0.9	1.0
Length " third " " "	1.4	1.6	1.69	1.7	1.72	1.75	1.9 calculated.
Width " " " " "	0.7	0.75	0.9	1.0	0.9	0.9	...
Depth " jaw at last premolar . . . . .	...	...	...	...	1.6	1.65	2.2
" " " " " true molar	1.5	...	...	...	...	1.75	2.4

¹ "Pal. Mem.," Vol. I, plate XVI, fig. 7.

² *Ibid.*, fig. 8.

³ P. 58.

⁴ Vol. XI, p. 86.

⁵ This specimen was

⁵ This specimen was obtained in the same district of the Punjab as the upper molars represented in figures 1 and 2 of the same plate, though at a later period. From the identity in the mineral condition of the two specimens, and from their condition of wear, I am strongly inclined to think that both upper and lower jaws belonged to the same individual.

In this table, taking first the third true molar (the length of this tooth in the last column being calculated from the length of the preceding tooth), we find such a gradual variation in the size of this tooth that it appears to me that, unless we make six species of the six specimens, which would of course be out of the question, we cannot specifically separate any of these teeth on the ground of size alone. It may be noticed that in five out of the six fossil specimens, the last true molar is smaller than the corresponding tooth of the specimen of the skull of the living giraffe in the Indian Museum¹: it is, however, quite probable that a considerable amount of variation in the size of the molars of the living species might be noticed if we had a sufficiency of specimens for comparison. It may further be noticed that in the fossil forms the last premolar is proportionately more elongated than in the recent species, a character by which it approaches the corresponding tooth in the sivathere and its congeners.

Having now noticed the variations in the size of the lower molars of the Siwalik giraffe, we may proceed to consider their variations in form.

In the specimen represented in figure 5 of plate XVI of this memoir, there are shown three perfect teeth, *viz.*, the last premolar (p.m. 4), the first true molar (m. 1), and the last true molar (m. 3); the bases of the penultimate premolar (p.m. 3) and of the second true molar (m. 2) also remain. In the last true molar the accessory 'column' is of very large size, and shows a distinct division into an inner ('lobe') and outer moiety ('crescent'), with a cavity separating the two. In this tooth, as also in the specimen represented in figure 6 of the same plate, the accessory 'lobe' seems to be more completely developed than in the living species; and a similarly large development is shown in all the other specimens of this tooth in the Indian Museum. In the specimen figured by Messrs. Falconer and Cautley the accessory 'column' is less complex, showing no distinct median pit. It is only in *Megaceros*, the giraffes and the sivatheres, according to Professor Owen², that this pit is developed in the accessory 'column' of the last lower molar, which is much less complex in all other ruminants. The development of this column in the last molar of the ruminants is evidently a survival from the highly complex form this tooth presents in many of the older pig-like bunodont animals, and it is thus interesting to trace its greater relative development in the living giraffe, and this becoming still greater in its fossil representative, and in the closely allied sivathere and its congeners.

The last true molar of the specimen represented in figure 5 of the same plate presents a minute tubercle in the 'median valley,' entirely lacking in all the other specimens of that tooth: the first true molar in the same specimen exhibits a large tubercle in the same position. The large tubercle in this tooth seems to be very generally constant in both the recent and fossil species; in the first lower true molar of the skull of a giraffe recently living in the Calcutta Zoological Gardens and now

¹ Another skull of an adolescent animal, formerly living in the Calcutta Zoological Gardens, has teeth slightly smaller than those of the specimen measured here.

² "Odontography," p. 535.

in the Indian Museum, this tubercle is absent. In the specimen No. B. 178 there is a tubercle of medium size in the 'median valley' of the second true molar, and a smaller one in the valley in front of the 'accessory lobe' of the last true molar.

In general characters the lower true molars are indistinguishable from those of the living species.

The specimen represented in figure 6 of plate XVI is the last right lower true molar, and is implanted in a fragment of the mandible. It was obtained by Mr. Theobald from a low horizon in the Siwaliks of the Punjab, and was formerly considered to indicate a second species of the genus.

Last lower milk-molar.—The last tooth we have to notice is the specimen represented in figure 8 of plate XVI. This tooth is the third right lower milk-molar of *Camelopardalis sivalensis*, as determined by comparison with the corresponding tooth of the existing species. The specimen has already been noticed on page 89 of the above-quoted notice in the "Records." The tooth consists of three well-developed divisions, increasing gradually in size from before backwards; the complete development of the third division distinguishes this tooth from the last true molar. The summits of the anterior division are alone slightly abraded by detrition, showing that the tooth belonged to an exceedingly young fawn. As far as a comparison can be made between this unworn tooth and a very much worn last lower milk-molar of the existing giraffe, no points of difference can be detected between the two: both teeth have a large tubercle in each of the two valleys on the outer side. The dimensions of the two specimens are as follows:—

	Recent.	Fossil.
Length of crown	1·21	1·2
Width " "	0·64	0·6

Lower premolars referred to Camelopardalis.—In my notice in the "Records" so frequently quoted, certain lower premolars were noticed, and referred to another species of *Camelopardalis*: a further examination of these specimens has shown that they probably belong to another genus: they will be again alluded to in the sequel. As elsewhere stated, the lower jaw referred by Dr. Falconer to the present genus on page 206 of the first volume of the "Palæontological Memoirs" belongs to some totally different genus.

Vertebral column.—The specimens figured in plate E of the "Fauna Antiqua Sivalensis" comprehend an imperfect fourth cervical vertebra from Perim Island (fig. 2¹); a complete fifth cervical from the Siwaliks (fig. 1), and a larger incomplete third cervical, also from the Siwaliks (fig. 11). The two first specimens are sufficiently described in the memoirs of Messrs. Falconer and Cautley already quoted: they indicate an animal smaller than an adult male of the living giraffe, though it is not shown whether they are smaller than the corresponding bones of a female of the existing species, which is often much smaller than the

¹ The serial position of all these vertebrae is incorrectly given.

male. The third specimen has never been described. In the descriptions of the plates of the "Fauna Antiqua Sivalensis" the dimensions of this bone are given as smaller than those of the other specimens, or the same as those of the figure; the figure is, however, said to be of half the natural size, and, therefore, these dimensions must be erroneous. The bone appears to indicate an animal at least as large as the existing species. The dorsal vertebra from Perim Island described by Dr. Falconer on page 207 of the "Palæontological Memoirs," together with another specimen similarly named in the Indian Museum, probably belongs to *Bramatherium*.

Limb-bones.—The specimens of limb-bones of giraffe, figured in the plate last quoted, comprehend the greater part of the right humerus (fig. 3), a fragment of the left radius and ulna (fig. 4), and four fragments of the metacarpus (figs. 6-9). I have been unable to compare these bones with the skeleton of the existing species, except in the case of the humerus, of which there is a cast in the Indian Museum. This bone is considerably larger than the humerus of a medium-sized African giraffe in the same institution, being nearly one inch wider across the condyles. The humerus No. 43, from Perim Island, described by Dr. Falconer on page 207 of the first volume of the "Palæontological Memoirs," and doubtfully referred to *Camelopardalis*, probably belongs to *Bramatherium*.

The only other bones in the collection of the Indian Museum that can be referred with any certainty to the present genus, are a broken radius, the associated right tarsus and part of the metatarsus, and several proximal phalangeals. The radius is referred by Dr. Falconer¹ to his *C. sivalensis*, and is described as being nearly equal in size to the corresponding bone of the existing species. The tarsus and metatarsus (No. B. 186, Ind. Mus.) were collected by Mr. Theobald in the Siwaliks of Niki; the portion of these elements now remaining comprehends all the bones of the tarsus, except the calcaneum, and rather more than half of the metatarsus. The latter bone has almost exactly the same proportions as the hind "cannon-bone" of the existing species, and when complete must have been of very nearly the same length. The fossil bone is distinguished by the vertical grooves on both its anterior and posterior surfaces being considerably deeper than in the recent homologue, indicating an affinity to an animal in which the "cannon-bone" consisted of its original elements: the medullary cavity of the shaft at the point of fracture is undivided. In the recent bone the nutrient foramen at the proximal extremity pierces directly through the shaft, while in the fossil it perforates the hinder surface obliquely so as to reappear on the superior surface. The close resemblance of the two bones renders it unnecessary to give a figure of the fossil. The proximal phalangeals closely resemble the corresponding bones of the existing species, but are somewhat less flattened on their anterior faces.

Summary.—The conclusions to be gathered from a study of the above-mentioned specimens are that the remains of the Siwalik giraffe indicates an animal showing some considerable variations in size, but whose mean dimensions were not

¹ "Pal. Mem.," Vol. I, p. 206, No. 690.

far from those of the existing species¹, the neck and limbs having attained their characteristic elongation in the pliocene period. The evidence of the teeth and bones before us does not appear to me to be sufficient to establish the existence of more than one species, though, taking into consideration the difficulty of distinguishing many of the fossil teeth from those of the existing species, it would be extremely rash to affirm that these remains did not belong to more than one species; such different species, if they existed, being very probably distinguished mainly by external characters. The fossil bones and teeth leaving, as we have seen, no doubt but that the Siwalik giraffes were constructed on the same plan as the living species, the interesting, but unfortunately ever unanswerable, question forces itself upon us, as to what was the external colour of the fossil form. Was the organisation of this type of animal always associated with the dappled chesnut and tawny hide of the existing giraffe, which, together with its towering form, we are told is a valuable means of concealment to its owner, as it browses in the splashes of alternating sunlight and shade among the lofty palms and mimosas of the plains of Southern Africa?

Distribution.—Remains of the Siwalik giraffe have been obtained throughout the Sub-Himalayan Siwaliks, but, in comparison with the remains of other ruminants, are decidedly of rare occurrence. They have also been obtained from the Siwaliks of Perim Island.

Comparison with other fossil species.—It may be observed, firstly, that, with the exception of *Camelopardalis biturigum* (the name of which was given in the same year), the Siwalik species has the priority of name over all the other species, and, therefore, its name would stand even if it were proved to be identical with either *C. attica* or *C. vetusta*.

Camelopardalis biturigum seems to be known only by a lower jaw, which, according to Professor Owen², differs very markedly from that of the living species, and is not therefore likely to be the same as the Siwalik form.

The upper molars of *C. vetusta*, figured by M. Duvernoy³, are so much worn, that it is difficult to compare them with the Indian specimens.

Camelopardalis attica, according to Professor Gaudry⁴, was of nearly the same height as the living species, but its limbs were of much more slender make⁵. It therefore seems to be the most specialised of the group. Some upper molars from Pikermi are provisionally referred by M. Gaudry to this species, but as they are not figured they cannot be compared with the Siwalik teeth.

Other alleged Siwalik species.—We have seen that the second Siwalik species of giraffe mentioned by Falconer and Cautley cannot be maintained; we have also

¹ It may be mentioned that Messrs. St. Hilaire, F. Cuvier, and Duvernoy considered that the variations in the living giraffe were such as to prove the existence of more than one species.

² See Gaudry, *Loc. cit.*, p. 249. As stated above, this form may be *Helladotherium*.

³ *Loc. cit.*

⁴ *Loc. cit.*

⁵ "Elle avait des os beaucoup plus minces."

shown, that a second species indicated by myself in the "Records"¹ on the evidence of a last lower molar must also be merged in *C. sivalensis*. It was thought in the same notice² that a third species was indicated by a last lower premolar, but this specimen now turns out to belong to *Hydaspitherium*.

GENUS II: VISHNUTHERIUM³, *Nobis*.

This genus was established by myself in 1876, on the evidence of a portion of the lower jaw of a giraffe-like ruminant: as the genus only contains one species its history may be given with that of the latter. The placing of this genus next to *Camelopardalis* is only provisional, and depends on the correctness of the determination of certain limb-bones to be noticed below. The skull is unknown.

Species: VISHNUTHERIUM IRAVADICUM, *Nobis*.

History.—The first notice of the lower jaw on which this genus is founded appeared in the "Records of the Geological Survey of India" for 1876⁴. The specimen, which is the only one known, is described, and the teeth figured, in the first volume of this work⁵: it was obtained from the Siwaliks of Burma, by Mr. W. T. Blanford.

The jaw is characterised by its slender form, and the true molars are constructed after the type of those of the giraffe, and have the same rugose enamel, but are of considerably larger size. They are further distinguished by the presence of a distinct 'cingulum' on the outer surface, and of a relatively large tubercle in the 'median valley' of both the first and second true molars: the tubercle in the first true molar is the larger of the two, and thus shows an analogy with the lower molars of the giraffe.

The above specimen is the only one which can be undoubtedly assigned to the genus, the reference to it of the other remains described below being merely provisional.

Upper true molars.—In figure 7 of plate XVI of this memoir are represented the second and third right upper true molars of a large ruminant, collected by Mr. Theobald in the Siwaliks of the Punjab near the village of Asnot. These teeth are but slightly worn, and in beautiful preservation, their enamel presenting the finely reticulate or rugose structure so characteristic of the giraffes and sivatheres. The 'lobes' on the outer sides of the teeth are placed obliquely to the long axis of the latter, so that the posterior overlaps the anterior 'lobe'; the central pits are very deep, and extensively connected with each other. The external or dorsal, surface of each tooth is noticeable for the comparatively slight development

¹ Vol. XI, p. 86.

² P. 87.

³ The name of this genus is taken from the third god of the Hindu trinity, Vishnu, and was applied to it as being analogous to Falconer's names *Sivatherium* and *Bramatherium*, from Bráma, and Shiva (Siva), the other members of this trinity.

⁴ Vol. IX, p. 103.

⁵ P. 55, pl. VII, figs. 1 & 2.

of the median 'costæ,' which in the posterior 'lobes' are scarcely recognizable at all. At the base of each of the inner 'crescents' there is a slight, though well-marked, 'cingulum;' no tubercle exists in the 'median valley.'

The general plan of structure of these teeth shows that they belong to some member of the giraffe family, in the extended sense in which it is employed here; they, however, differ from the corresponding teeth of all described members of that family, this difference being mainly shown by the want of development of the 'costæ' and the presence of the 'cingulum.' These points of difference will be more particularly pointed out when we come to consider the other larger members of the family.

The teeth, though considerably larger, present a certain resemblance to those of the elk (*Alces palmatus*), but are distinguished by the smaller development of the antero-external angles of the 'lobes,' whereby the centre of the outer surface of each 'lobe' is less depressed than in the elk. The fossil teeth are further distinguished by the presence of the 'cingulum' and by the greater rugosity of the enamel; they, however, undoubtedly approach the molars of *Alces* more nearly than do those of any other member of the family.

The dimensions of the two teeth are as follows:—

Length of two teeth	. . . . .	3.2
" of second true molar	. . . . .	1.62
Width of " "	. . . . .	1.75
Length of third " "	. . . . .	1.67
Width of " "	. . . . .	1.56
Height of anterior crescent of ditto	. . . . .	1.12

If these dimensions be compared with those of the lower molars of *Vishnutherrium iravadicum* given in the first volume¹, it will be seen that the upper and lower teeth correspond well enough in the matter of size to have belonged to the same species. They further correspond in their general plan of structure as closely as do the upper and lower molars of the same species of ruminant, and agree in the structure of their enamel, and in the presence of a 'cingulum.' Both specimens are further unique examples of their respective series, and therefore, evidently belonged to a very rare animal; this removes any difficulty of associating the two specimens which might be felt on account of the distance of the localities where they were respectively obtained.

From the above circumstances it appears highly probable that these two specimens belong to the same species, or at all events to the same genus of ruminant, and they are accordingly provisionally associated. Should this association eventually prove erroneous, the upper teeth must be referred to a new species, or genus, as the case may be, though there is a very strong presumption that the genus is correctly determined.

Metatarsus.—In figure 3 of plate XVII is represented, of one-fifth the natural size, the nearly complete metatarsus of a large and long-limbed ruminant, evidently

nearly allied to the giraffe. The specimen, which only lacks the inferior condyles, was obtained by Mr. Theobald from the Siwaliks of the Punjab. Below, the dimensions of this bone are compared with those of the metatarsus of a medium-sized giraffe in the Indian Museum, and also with those of a larger specimen of the same bone given by Professor Gaudry in his description of the remains of the Pikermi giraffe.

	Specimen.	Giraffe.
Length of complete bone	(?) 20.5	26.5—28.5
Length to condylar junction	19.0	25.0—27.0
Transverse diameter above condyles	3.2	
Circumference of shaft	8.6	

These dimensions show that the fossil bone is much shorter, and relatively stouter than the metatarsus of the African giraffe. In its general form and proportions, however, the bone comes nearer to the latter bone than to the metatarsus of any other animal, and the general resemblance is so close as to leave little doubt that the animal to which the bone belonged must have been a member of the same family as the giraffe. Its greater shortness, on the other hand, connects this bone with the sivatheroid animals, and thus bridges over the gap hitherto existing between these animals and the giraffes, and renders it difficult to refer them to two different families.

The bone is longer and slighter than the metatarsus referred by Falconer and Cantley to *Sivatherium giganteum*¹ (plate xvii, figure 2), although that bone, if rightly named, judging from the length of the metacarpus (*ibid.*, figure 1), is an unusually long specimen. The bone before us is further distinguished from the anterior "cannon-bone" of *Sivatherium* by the relatively smaller size of its terminal expansions, and the greater degree of development of the grooves on its anterior and posterior aspects. All these divergences from the *Sivatherium* type approximate to that of the giraffe.

The metatarsus of *Helladotherium* (plate xvii, figure 4) is distinguished by being much shorter and stouter; and, judging from the shape of the metacarpus (*ibid.*, figure 10), and the lower half of a metatarsus in the Indian Museum, the metatarsus of *Hydaspiatherium* is also a shorter and stouter bone.

An inferior extremity of the metacarpus of *Bramatherium*, in the Indian Museum, shows that the "cannon-bones" of that genus were likewise of a more massive type than the bone before us.

There now only remains *Vishnutherium*, among the known genera of Indian giraffoids, to which this specimen can possibly belong, and as it is of about the right dimensions to have belonged to the same animal as the teeth of that genus, it

¹ A note on the reference of this bone will be given under the head of *Sivatherium*.

is provisionally referred to it. It is, however, quite possible that this reference may be eventually proved incorrect; but this will not interfere with the value of the specimen as proving the former existence of a large ruminant forming a connecting link between the giraffe and the sivathere, but nearer the former than the latter. I have preferred to risk a false reference rather than to form a new genus for the reception of this one bone, which will have to be done if it do not belong to *Vishnuthierium*.

Sixth cervical vertebra.—The 'centrum' of a sixth cervical vertebra of a large species of ruminant, represented in figure 2 of plate xviii of this memoir, was obtained from the Siwaliks of Asnot, in the Punjab, by Mr. Theobald¹. The specimen, which is represented of the natural size, is viewed from the left lateral aspect. It exhibits the whole of the 'centrum,' and on the left side the vertebrarterial canal and the greater part of the transverse process. The descending lamina of the latter process is broken away on the left side, but on the right is nearly complete, wanting only its preaxial angle. The postaxial eup is of great size and depth. From the large size of this bone it is quite evident that it belonged to some member of the present family: it is shorter than the sixth cervical of the giraffe, and longer than that of *Sivatherium*. It is of smaller size, and of more slender proportions than the cervical vertebra referred in the sequel to *Hydaspitherium*; and since the teeth of *Vishnuthierium* indicate a slighter animal than *Hydaspitherium*, the present bone is provisionally referred to the former genus. In respect of its slender form it agrees well with the "cannon-bone" which we have already referred to the same genus. The 'centrum' has no trace of a keel on its hæmal aspect. In the following table the dimensions of this vertebra are compared with the dimensions of a homologous vertebra of *Sivatherium*, in the collection of the Indian Museum, and figured in plate xxii of this volume; and also with those of a sixth cervical vertebra of the pleistocene ox of the Narbada (*Bos namadicus*).

	Bos.	Vishnuthierium.	Sivatherium.
Length of centrum superiorly	2·6	4·7	4·3
Vertical diameter of condyle	2·0	2·6	3·3
Transverse " " "	1·45	1·75	2·6
Projection of descending lamina below centrum	1·8	1·7	3·0(?)
Length of lamina	2·1	3·6	3·0
Length of base of transverse process	0·6	2·9	2·1

These dimensions show that the vertebrae of *Sivatherium* and *Bos* have much the same proportions, and are constructed on the same general plan. The characteristic points in these genera are the relative shortness of the centrum and the great vertical depth of the descending lamina of the transverse process. In the vertebra of

¹ It is not improbable that a vertebra in the collection of the Geological Society, from Baluchistan, may belong to this species.

the vishnuthere, we have, on the contrary, an elongated centrum, while the descending lamina of the transverse process is comparatively but slightly developed inferiorly, and very largely antero-posteriorly. In all these characters the vertebra makes a marked step in the direction of the giraffe, in which the centrum is much elongated and the descending lamina of the transverse process so little developed inferiorly, and so largely antero-posteriorly, as to be divided into a distinct anterior and posterior portion. The vertebra of *Vishnutherium* is indeed intermediate in character between that of *Sivatherium* and *Camelopardalis*, but seems to partake more of the characters of the latter than the former. This vertebra has no trace of a median keel inferiorly.

It may be added that should this vertebra be wrongly referred to *Vishnutherium*, this will not affect its value as indicating a connecting link between the giraffe and the sivathere. If it does not belong to *Vishnutherium*, it must probably belong to a new genus, as the vertebrae of *Hyaspitherium* are known. It indicates an animal whose neck was intermediate in length between the giraffe and other ruminants, and therefore agrees well with the proportions assigned to *Vishnutherium* from the study of the metatarsus.

Distribution.—If all the remains here assigned to *Vishnutherium* be rightly determined, the animal must have formerly lived in Burma and the western Punjab, and was of rare occurrence.

Summary.—Whether these remains belong to one or to several species or genera, they unmistakably indicate a connecting link (or links) between the sivathere and the giraffe which so effectually bridges over the gap hitherto existing between those animals, as to do away with all family distinctions between the two.

GENUS III: HELLADOTHERIUM¹, Gaudry.

This genus was established by M. Gaudry, and contains only one species: it is distinguished from all the other members of the family by being totally unprovided with horns, and would accordingly seem to be nearest to the ancestral and least specialised type of the family.

Species: HELLADOTHERIUM DUVERNOYI, Gaud. and Lart.

History.—This species, the only representative of the genus, has been described under its present generic name by Professor Gaudry², from Pikermi, and nearly the whole of its osteology illustrated. In the same work³ reference is made to a nearly perfect cranium from the Sub-Himalayan Siwaliks, referred originally by Falconer and Cautley to a female individual of *Sivatherium giganteum*, and it is shown that this cranium must be referred to *Helladotherium*, and very probably

¹ *Hellas* (Greece) and *Therion*.

² "Animaux Fossiles et Géologie de l'Attique," p. 252 et seq.

³ P. 260.

to the Pikermi species. A note on this determination has been recently published by myself¹.

Cranium.—Four views of the cranium referred to above are given in plate A of the "Fauna Antiqua Sivalensis" (figs. 1, 1a, 1b, 1c). The specimen is fairly perfect, with the exception of the premaxillæ and the two zygomatic arches, which have been entirely broken away. The skull is completely hornless, and is remarkable for the greatly overhanging occiput, and the great relative length of the temporal fossæ. The specimen shows the whole of the molar series. It is probable that the teeth if found alone could not be distinguished from those of some of the following genera. The dimensions of this skull are given in the "Palæontological Memoirs"². According to Professor Gaudry the only points of difference between it and the skull of the Pikermi specimen of *H. duvernoyi*, are that the premolars are a little larger in proportion to the true molars, that the palatine cleft is not so deeply cut, the occipital condyles less prominent, and the pits, on either surface of the occipital crest, less deep. These differences do not seem sufficient to justify a specific distinction of the two skulls.

From the absence of horns I have placed the helladothere nearer to the giraffe than the next genus, as it would seem incongruous to place this hornless genus between the *Hydaspiatherium* and the *Sivatherium*, both of which carry such complex horns. As we shall see immediately, however, the structure of the limbs shows that the present genus is nearer to the *Sivatherium* than to the *Hydaspiatherium*.

Canon-bones.—Except the skull just described, no remains have been recognised in India as belonging to this genus, and our comparisons must, therefore, be derived from the specimens described by M. Gaudry.

In figures 4 and 5 of plate XVII of this memoir are represented the metatarsus and metacarpus of *Helladotherium duvernoyi*, copied from M. Gaudry's great work. The metatarsus (fig. 4) is seen to be a very stout bone, of thicker proportions than the corresponding bone doubtfully referred to *Sivatherium* (fig. 2). The metacarpus is also of a very stout type, but is considerably larger than the corresponding bone of *Sivatherium* (fig. 1). Its length is 16 inches, and its breadth superiorly 4·28 inches, and inferiorly 3·95 inches.

It is a stouter and probably shorter bone than the metacarpus of *Hydaspiatherium* (fig. 10), and, therefore, in this respect is more closely related to the *Sivatherium* than is the latter genus, while, as already said, in cranial characters it is nearer to the giraffe.

The discrepancy in the serial position of the helladothere when looked at from cranial and skeletal points of view, shows, as we have elsewhere remarked, that a strictly lineal classification of the members of this family is impossible, and further indicates the probability that the animals under consideration are not an ancestral series, as is almost proved by their co-existence in time, but rather that

¹ R. G. S. I. " Vol. XV, p. 31.

² Vol. I, p. 53.

they are only some scattered members of the common stock whence the giraffe and sivathere took their origin.

Distribution.—Remains of *Helladotherium* have been obtained in Europe, and from the Siwaliks in the neighbourhood of the Markanda river.

GENUS IV: HYDASPITHERIUM¹, *Nobis*.

Synonym, *Hydaspidotherium*, *Nobis*.

This genus was established by myself in 1876² under the name of *Hydaspidotherium*; it is characterised by possessing one common horn-base placed on the upper part of the frontals, and which may have carried either one or two pairs of horns. It contains two species, both from India, but there is some uncertainty as to the generic reference of the second.

Species: 1. HYDASPITHERIUM MEGACEPHALUM, *Nobis*.

Synonym: *H. leptognathus*, *Nobis*.

History.—This species is the one on which the genus is founded, and its history is, therefore, the same as that of the genus. The specimen on which the species and genus was founded is a nearly complete cranium, wanting the horn-cores, discovered by Mr. Theobald in the Siwaliks of Asnot, in the western Punjab. This fine specimen is figured and fully described in the first volume of this work.

At a subsequent period certain upper molar teeth were described by myself and referred to the present species³, while in the same notice a mandible was described under the new name of *H. leptognathus*, which will be shown to belong, not improbably, to the present species. No other remains belonging to this species have been hitherto described.

Cranium.—The cranium is at once distinguished from those of all its allies by carrying a large and subquadrate compound horn-base immediately in front of the occipital crest, from which the probably branched horns must have taken their origin. It has been suggested that this common horn-base corresponds to the posterior horns of *Sivatherium*; but a later examination of the cast of the skull of *Bramatherium* has thrown doubt on this view, as will be subsequently shown. For the details of the cranium the reader is referred to the description already quoted. A noteworthy point is the presence of a large lachrymal vacuity, which is wanting in *Sivatherium*, and indicates strong affinity with the giraffe.

Upper molars.—In describing the skull of the present species a description of the upper molar teeth was given, while other detached upper teeth are described

¹ *Hydaspes*, the Jhelam, and *Therion*; from the locality whence the specimen was obtained.

² "Rec., Geol. Sur. of India," Vol. IX, p. 154.

³ P. 159, pls. XXVI, XXVII.

⁴ "Rec. Geol. Sur. of India," Vol. XI, p. 90.

in the notice in the "Records," to which reference has already been made. In these two notices it was shown that these teeth are distinguished from the upper molars of *Sivatherium* by their inferior size, by the finer texture of their outer surface, by the absence of any plication of the enamel of the central pits, and by the lesser development of the 'costæ' on the external surface of the 'lobes.' It was further shown that there was a certain amount of variability in the latter character.

In figure 3 of plate XVIII of this volume there are represented two associated upper molars of a large ruminant of slightly larger size than the above-mentioned molars of *H. megacephalum* noticed in the "Records." These two teeth were obtained in association with the corresponding teeth of the opposite side, by Mr. Theobald in the Siwaliks of the Punjab, and are in an intermediate condition of wear. They are implanted in the hinder portion of the left maxilla, and are thus shown to be the second and third true molars.

These teeth, from having been found in the district where the remains of *Hydaspitherium* are so common, and also from their resemblance in form to the teeth in the above-mentioned skull of *H. megacephalum*, are referred to that species. Their dimensions are given in the first column of the following table, while in the second are given those of a detached specimen of smaller size :—

Length of second true molar	. . . . .	1.95	— ...
Width " "	. . . . .	1.9	— ...
Length of third " "	. . . . .	1.85	— 1.6
Width " "	. . . . .	1.8	— 1.55

The teeth in the figured skull are intermediate in size between these two extremes, and it would thus seem that no specific distinctions can be drawn merely from variations in the size of the upper molars. The smaller teeth are about the size of the molars of *Bramatherium*, while the figured specimens are nearly equal in size to the molars of small-sized individuals of *Sivatherium*.

In the figured teeth there is a trace of a 'cingulum' on the inner 'crescents,' which appears liable to a certain degree of variation in the different specimens.

Besides being generally smaller, the upper molars of *Hydaspitherium megacephalum* are at once distinguished from those of *Sivatherium* by the much less development of the 'costæ' on the outer surfaces of the 'lobes'—a distinction so well marked that there is never any difficulty in determining isolated specimens.

The upper molars of *Vishnutherium* are distinguished by the almost complete absence of any median 'costæ' on the outer surface of the 'lobes,' and by the presence of the distinct 'cingulum.'

When we come to *Bramatherium*, on the other hand, we find a much closer resemblance between its upper molars and those of the present species, and it is pretty certain that if the skulls of the two genera were unknown, the teeth would be referred to the same genus, if not to the same species; indeed, it is quite possible that some of the teeth in the Indian Museum from the Punjab classed as *Hydaspitherium*

therium may really belong to *Bramatherium*, though no remains of the latter genus have yet been determined from that district. The 'costæ' in the molars of *Bramatherium* seem on the whole to be slightly more pronounced than in *Hydaspiatherium megacephalum*.

According to Professor Gaudry¹ the upper molars of *Helladotherium* are very like those of *Bramatherium*, and it is, therefore, probable that if we had only the evidence of the teeth to depend on, all the three above-mentioned genera would be merged in one.

Mandible.—In cases where more than one species of a genus, or several closely allied genera are found in the same formation, there is always extreme difficulty in assigning the different remains of these allied forms to their respective owners, and this is especially the case in the instance of lower jaws which have to be assigned to species named from the skulls or upper jaws and teeth. This difficulty makes itself felt in the case of assigning the proper lower jaw to the present species, and the difficulty is so great that the following determination in the case of this and the next species, must be considered to be open to a considerable element of doubt. It has, however, been considered preferable to risk wrong association rather than to make unnecessary and untrue species upon the evidence of detached lower jaws. In my previous notice in the "Records" so often referred to already, there is briefly described² a nearly complete right ramus of the mandible of a sivatheroid ruminant, under the name of *Hydaspiatherium leptognathus*. This jaw was referred to a new species, under the impression that the females of the sivatheroids were hornless, of which there is now no evidence³, and that consequently the one known skull of *H. megacephalum* was that of a full-sized male. The foregoing reference of larger upper teeth to the latter species has removed the difficulty of difference of size between the skull of *H. megacephalum* and the present lower jaw, and there is, therefore, considerable probability that the latter may be referred to the same species.

The specimen, which was obtained by Mr. Theobald in the Sivaliks of the Punjab, is represented in plate XIX of this memoir, and will be seen to be nearly complete, only wanting the symphyseal extremity, and a portion of the coronoid process. It is in an excellent state of preservation, and contains the whole of the permanent molar series, which has been but a comparatively short time in use, the animal having only just attained its full dimensions at the time of its death.

The general form of the jaw is much like that of the jaw of the giraffe and the antelopes, but the horizontal ramus is more curved, both laterally and inferiorly, than in the former animal, while the anterior border of the ascending portion more nearly approximates to a right angle with the long axis of the horizontal portion. The 'angle' is well developed, but less so than in the giraffe. The horizontal portion is slender, and curves outwards to a considerable extent in the middle, so that the part immediately below the hinder 'crescent' of the first

¹ "Animaux Fossiles et Géologie de l'Attique," p. 260.

² Vol. XI, pp. 92-93.

³ "Records," Vol. XV, p. 31.

true molar is by far the most prominent point on the whole of the outer surface of the jaw.

The molars are constructed after the usual type prevalent in the present family, and are coated by a moderately rugose enamel, of somewhat finer structure than that of *Sivatherium*. The molars are further distinguished from those of the latter genus by the smaller degree of development of the 'costæ' on the inner surfaces of the 'lobes,' as well as by the greater obliquity of the 'lobes' themselves to the long axis of the crown. The penultimate premolar (p.m. 3.) differs from that of the giraffe in possessing no distinct 'lobe' on its inner aspect, the processes from the 'crescent' forming the inner surface. In this respect *Hydaspitherium* seems to agree with all other ruminants in which the penultimate lower premolar is known, the specialisation of that tooth in the giraffe being apparently peculiar to that animal.

The anterior 'crescent' of the first true molar in the jaw before us presents a slight rudiment of a 'cingulum' anteriorly, and in all the three true molars there is a very minute tubercle in the 'median valley,' attached to the anterior 'crescent,' this rudimentary tubercle being most developed in the first true molar.

In the following table the dimensions of the lower jaw under consideration are compared with those of a lower jaw of *Camelopardalis giraffa* in the Indian Museum and also with those of a lower jaw of a full-sized individual of *Sivatherium giganteum*¹.

	Camelopardalis.	Hydaspitherium.	Sivatherium.
Length of whole molar series	6.5	10.3	...
" of four last teeth	4.1	7.7	9.0
" from 'angle' to 'diastema'	10.5	14.5	...
Height from " to summit of condyle	5.8	7.5	...
Depth at middle 'crescent' of last molar	1.75	3.3	4.7
" at hinder " of first "	1.75	2.52	3.45
" at second premolar	1.55	2.4	3.0
Thickness at first molar	1.0	1.95	2.15
Length of first true molar	1.0	1.85	2.05
Width of " "	0.9	1.3	1.55
Length of second "	1.15	1.87	2.15
Width of " "	0.9	1.25	1.55
Length of third "	1.75	2.64	2.95
Width of " "	0.9	1.25	1.6
Height of " "	1.14	1.7	2.0(?)

The jaw of *Sivatherium* measured in the foregoing table is probably that of a male individual, other specimens being slightly smaller, and probably belonging

¹ This jaw is in the British Museum, and will be alluded to in the sequel. It is figured in the "Palæontological Memoirs" (pl. XXI, fig. 1), and there is a cast of it in the Indian Museum. It contains the last premolar, and the three true molars.

to female animals. The latter specimens have the same proportions as the one measured.

The molars of the figured jaw are distinguished from those of *Bramatherium perimense*¹ by their superior size. If, however, the lower molars of the two forms had been discovered without other remains, their differences would be insufficient to indicate any generic distinctions between their respective owners.

From the lower molars of *Vishnuthierium*² the teeth before us are distinguished by the absence of any well-marked 'cingulum,' or distinct tubercle in the 'median valley;' their superior size is another distinctive point of minor importance.

It is no easy matter, without the actual specimens before one, to indicate how the teeth under consideration differ from those of *Helladotherium duvernoyi*, of which only some imperfectly developed specimens are figured by M. Gaudry³.

Since the length of the second true molar in the jaw before us agrees so nearly with that of the corresponding upper tooth referred to *H. megacephalum* and represented in figure 3 of plate XVIII of this memoir, it seems probable, in spite of the opinion expressed to the contrary in the note in the "Records," that the specimen may be referred to that species.

Upper milk-molars.—Mr. Theobald's Sivalik collection has several specimens of the upper milk-molars of this species, but as they do not exhibit any striking features, they will not be further alluded to.

Lower milk-molars.—In figure 4 of plate XXI of this memoir is represented a fragment of the right ramus of a mandible of a young sivatheroid, collected by Mr. Theobald in the Siwaliks of the village of Patela in the Potvár district of the Punjab. The specimen contains two teeth, the first of which is broken, and is the penultimate milk-molar; but has only the posterior half remaining and consisting of a distinct 'crescent' and 'lobe.' The second tooth has three complete divisions, and is thus shown to be a last milk-molar. It has also a large tubercle in each of the 'valleys,' and closely resembles the corresponding tooth of the giraffe (plate xvi, figure 8) and of the sivathere (plate xxi, figure 3), being intermediate in size between the two. The specimen is referred to the present genus from its clearly belonging to a giraffoid animal, and from its relative size. Its specific determination is, however, a matter of some doubt. The length of the last milk-molar is 1.9 inches; and the depth of the jaw 1.95 inches, at the front of this tooth. A precisely similar specimen is described on page 95 of the eleventh volume of the "Records," where it was suggested that it might belong to the present species.

In figure 3 of plate XVI of this volume is represented a small lower molar of a giraffe-like animal which on page 87 of the notice in the "Records" already quoted, was considered to be the left penultimate premolar of *Camelopardalis sivalensis*. The specimen last noticed shows, however, that it must probably be the penultimate milk-molar of a species of *Hydaspthierium*, as it agrees so closely with the broken specimen of that tooth in the last-mentioned jaw. This specimen, in company with another precisely similar one, was collected by Mr. Theobald in the Siwaliks of the

¹ *Supra*, Vol. I, pl. VII, fig. 13.

² *Ibid.*, fig. 2.

³ *Loc. cit.*, pl. XLI, fig. 3.

Punjab. The remarks made in the previous notice as to the relative height of the crowns of the teeth in the giraffe and sivatheroids do not apply to the milk-molars. The tooth differs from the corresponding milk-molar of the giraffe, by the absence of the 'lobe' on the inner side (*from which the tooth is viewed*) of the first division of the crown, and by the formation of a distinct pit at the antero-internal angle of the tooth (*right side of figure*). The jaw in which this tooth is implanted is only 1·1 inches in depth, and, therefore, the specimen cannot belong to the same species as the last. From the slenderness of the second jaw it is possible that it may belong to the present species, while the first and stouter jaw may belong to *H. grande*, to which a much stouter form of jaw has been assigned. No certainty can, however, attach to these determinations.

Limb-bones.—Among Mr. Theobald's Punjab Siwalik collection are numerous limb-bones of a large ruminant, of smaller and slighter make than those of *Sivatherium*, and probably belonging to the present genus. Some of these bones, namely, an associated humerus, fore and hind 'cannon-bones,' a carpus, and proximal phalangeals, were obtained at Niki, and may pretty certainly be referred to the present species, whose teeth are abundant in that locality. In the present notice only such of these limb-bones as illustrate the divergence of the present genus from *Sivatherium* will be further alluded to.

Metacarpus.—In figure 10 of plate XVII of this memoir there is represented a specimen of the left metacarpus of *Hydaspitherium megacephalum*, from Niki. The specimen is unfortunately broken in the middle, and a certain portion is missing, so that the precise length of the bone cannot be ascertained. From the diameter of the fragments, however, when complete, it could not have been shorter than is represented (on a scale of $\frac{1}{3}$ th) in the figure. The bone was associated with the carpus, and with one of the proximal phalangeals (figure 11). A comparison of the figure with that of the metacarpus of *Sivatherium* (figure I of same plate) shows that the two bones are of very different types of structure, that of *Hydaspitherium* being longer than that of *Sivatherium*, while its articular surfaces are smaller. The shaft of each of the two bones has nearly the same dimensions, the articular expansions being relatively smaller than in *Sivatherium*.

The form and dimensions of the bone come much nearer to those of the metacarpus of *Helladotherium* (figure 5 of same plate), but the Indian bone is slightly the more slender of the two, and the condylar expansion is less marked.

The dimensions of the three above-mentioned metacarpal bones are compared in the following table:—

	Sivatherium.	Hydaspitherium.	Helladotherium
Total length	13·7	17·0 (f)	16·0
Breadth of superior surface	4·7	4·2	4·28
„ of inferior „	4·7	3·6	3·95
„ of single condyle	2·2	1·66	...

These dimensions show that the anterior 'cannon-bone' of the hydasphithere forms another step from that of the helladothere in the direction of the giraffe. The head of the Indian bone shows a distinct remnant of the second metacarpal on its postero-internal angle, even more distinctly than that pointed out by Professor Gaudry in *Helladotherium*¹, while a peculiar projection on the outer side of the head appears to be the indication of a remnant of the fifth metacarpal. In the inferior portion of the bone there is a median septum dividing the medullary cavity into two tubes, but superiorly these two tubes have coalesced. This septum indicates a close affinity with animals in which the metacarpals were not fused into a 'cannon-bone.'

Metatarsus.—We have no complete specimen of the metatarsus. A fragment of the condylar extremity belonging to the same individual as the metacarpus, shows the same dimensions across the condyles. There is a wide groove on the anterior surface, which is wanting in the metacarpus. The medullary cavity is divided into two divisions by a median septum.

Proximal phalangeal.—The external proximal phalangeal bone associated with the metacarpus described above, is represented in figure 11 of plate XVII, of half the natural size. The bone is nearly as long as the corresponding bone of *Sivatherium* (plate XVII, figure 9), but is much slenderer and slighter, approaching in this respect the giraffe. The proximal phalangeal of *Helladotherium* seems very similar to the present specimen.

Calcaneum.—The last bone calling for any special notice is the calcaneum, of which a complete specimen from the Punjab is represented in figure 7 of plate XVII, of half the natural size. This bone is referred to the present species as being distinct from the calcaneum of *Sivatherium*, and as evidently belonging to a large sized ruminant allied to the giraffe. It resembles the corresponding bone of the latter animal indeed, very closely, being mainly distinguished by its much larger size. It is readily distinguished from the calcaneum of *Sivatherium*, of which an imperfect specimen is represented in figure 12 of plate D of the "Fauna Antiqua Sivalensis," by its superior surface being broad and flattened for the greater part of its length in place of being produced into a sharp edge. In this respect the bone agrees with the calcaneum of the giraffe. The dimensions of this bone are compared below with those of the calcaneum of *Sivatherium*:—

	<i>Sivatherium</i> .	<i>Hydasphithereum</i> .
Total length . . . . .	...	8.6
Projection of heel	6.2	5.5
Breadth of calcaneal tuberosity . .	2.9	2.1
Height " " "	2.8	2.0

¹ "Les Enchainements du Monde Animal," figure 147.

Vertebral column.—In the Siwalik collection of the Indian Museum there are several cervical vertebræ of large ruminants of a different form from the one referred above to *Vishnuthierium*, and from those of *Sivatherium*, figured in the "Fauna Antiqua Sivalensis," and those described by Dr. Falconer in the "Catalogue of the Siwalik collection of the Asiatic Society of Bengal." These specimens were all obtained from the western Punjab, and doubtless belong to the present genus.

Atlas.—The first of these specimens is an atlas vertebra, collected by Mr. A. B. Wynne (Indian Museum, No. B. 380). It has much the same proportions, but is of smaller dimensions than the atlas of *Sivatherium*, represented in figure 1 of plate B of the "Fauna Antiqua Sivalensis."

Axis.—The next specimen is an axis vertebra, collected by Mr. Theobald (Indian Museum, No. B., 381). This specimen is nearly as large as the corresponding vertebra in the same collection described by Dr. Falconer¹, but has very different proportions, as is shown by the following measurements:—

	Hydaspietherium.	Sivatherium.
Width of articulating surface for atlas	5.5	5.6
Length of lamina of neural arch	3.8	2.6
Interval between anterior aperture of neural canal and hind border of post-zygapophysis	6.3	4.4

The posterior extremity of the 'centrum' of the vertebra of *Hydaspietherium* has been broken away, so that the length of this part cannot be compared in the two specimens. The dimensions given above, however, clearly show that the vertebra in question is of a more elongated type than that of *Sivatherium*.

Fifth cervical.—A specimen of a fifth cervical, collected by Mr. Theobald (Indian Museum, No. B. 285), is relatively longer and narrower than the corresponding vertebra of *Sivatherium*, of which a specimen is described by Dr. Falconer², and the condyle is proportionately longer and narrower.

The following are the dimensions of the two specimens:—

	Hydaspietherium.	Sivatherium.
Length of inferior surface to condyle	3.8	3.4
Width between inferior lamellæ of transverse processes	2.3	3.5
Vertical diameter of condyle	3.5	2.92
Transverse " "	2.72	2.3

¹"Pal. Mem.," Vol. I, p. 273. Ind. Mus., No. B. 376. An imperfect specimen is figured in "F. A. S." pl. B., fig. 3.

²"Pal. Mem.," Vol. I, p. 276, No. 338.

Sixth cervical.—A sixth cervical vertebra of a ruminant is described by Dr. Falconer¹ as that of a small sivathere. This vertebra is, however, narrower than the sixth cervical of *Sivatherium* (plate XII), and is distinguished by a distinct hypapophyseal keel. It may belong to the present species.

The dimensions of the two specimens are given below :—

	Hydasitherium.	Sivatherium.
Length of superior surface of centrum	4.1	4.3
Width between inferior lamellæ of transverse processes	3.02	3.3
Vertical diameter of condyle	3.2	3.3
Transverse „ „	2.3	2.6

The foregoing comparisons indicate that the hydasitherium was provided with a neck somewhat longer than that of the sivathere.

Distribution.—With the exception of the sixth cervical vertebra described above, which seems to have come from the true Siwalik hills, remains of the present species have only been obtained from the Siwaliks of the Punjab, between the Jhelam and Indus rivers.

Summary.—The examination of all the remains in the Indian Museum, which can be referred to *Hydasitherium megacephalum* indicates that, as far as regards its length of limb, it was further removed from the sivathere than is the helladothere; the structure of its horns, however, places it nearer to the former. In the length of its neck it makes one step from the same in the direction of the vishnuthere and the giraffe; to the latter of which it is allied by the presence of a lachrymal vacuity.

Abolition of H. leptognathus.—The provisional reference of the mandible described above to the present species renders it necessary that the species known as *H. leptognathus* should be withdrawn.

Species: 2. HYDASPITHERIUM GRANDE, Nobis.

History.—This species was founded upon the evidence of an upper molar of a sivatheriod, obtained by Mr. Theobald in the Siwaliks of the Punjab, and briefly described in the "Records" for 1878². The tooth differed from the molars of all other sivatheriods, but seemed to be nearest to those of *H. megacephalum*. It is, however, quite possible that this reference, which is merely provisional, should turn out incorrect, and that the tooth must be referred to a new genus. The provisional reference to *Hydasitherium* is intended to obviate the creation of a new genus without adequate cause. In the same notice³ a ramus of a mandible was pro-

¹ "Cat. Mus., A. S. B.," No. 603; not mentioned in "Pal. Mem." Ind. Mus., No. B. 382.

² "Vol. XI, p. 93.

³ *Lec. Cit.*

visionally referred to the same species. No other remains have been hitherto described.

Present notice.—In this memoir the two specimens mentioned above are described and figured, and a calcaneum and proximal phalangeal, different from those of any other sivatheroid, are provisionally referred to the species. No other parts of the skeleton have been yet determined.

Upper molar.—In figure 2 of plate XXI of this volume the specimen of an upper true molar, noticed above, is figured; it is the penultimate tooth of the left side, and is scarcely touched by wear; the summit of the anterior 'lobe' has been somewhat damaged. The characteristic rugose structure of the enamel, and the large size of the specimen shows that it belongs to the present group of ruminants. The characteristic points of the tooth are the great height of the crown, the slight development of the median 'costa' on the anterior 'lobe,' and its complete absence on the posterior 'lobe.' The latter points at once distinguish the tooth from the molars of *Sivatherium*. The teeth of *Bramatherium*, and most of those of *Hydas-pitherium megacephalum* differ in the greater development of the 'costæ,' though some varieties referred to the latter make an approach in this respect. The latter teeth have, however, relatively lower crowns, the dimensions being as follows:—

	H. grande.	H. mega.
Length of crown	1·8	1·6
Width „ „	1·8	1·7
Height „ „	1·6	1·2

The absence of a 'cingulum' distinguishes the tooth from the molars of *Vishnu-therium*. On the whole, it seems probable that the present and another similar tooth in the Indian Museum belong to a second species of *Hydas-pitherium* for which the name *H. grande* has been proposed.

Mandible.—In plate XX of this memoir is figured the greater portion of the left ramus of the mandible of a sivatheroid, obtained by Mr. Theobald in the Siwaliks of the western Punjab, and provisionally referred by myself in the "Records"¹ to the present species. The following description is mainly copied from that notice. The specimen is broken off immediately behind the last true molar, and extends as far forwards as the commencement of the symphysis; it shows the last premolar and the three true molars, the first and last teeth having only been in use for a short time. The ramus of the mandible differs from the one referred to *H. megacephalum* (plate XIX) by its much greater vertical depth, and by its outer surface being slightly concave, in place of markedly convex, in both of which respects it approaches the mandible of *Sivatherium*. The structure of the molars, however, at once distinguishes the specimen from the latter genus, as it

¹ Vol. XI, p. 83.

does also from *H. megacephalum*. The 'lobes' of the teeth are placed still more obliquely to the long axis of the jaw than in the latter species, while the median 'costæ' are much less developed, those of the second 'lobes' being almost obliterated. If a rod be placed on the inner surfaces of the last true molar, it will only rest on their posterior 'costæ,' while in *H. megacephalum* it will rest on the median 'costæ' of the hind 'lobe,' and the posterior 'costæ' of the fore 'lobe;' in *Sivatherium* a similarly placed rod will rest on the median 'costæ' of both 'lobes.' This shows that the teeth of the present specimen are further removed from the *Sivatherium* type than those of *H. megacephalum*. The last premolar is a very characteristic tooth, and is remarkable for the great proportionate development of its posterior 'crescent' and 'lobe.' The inner surface of the 'lobe' is fan-shaped, and nearly flat, the median 'costa' being very slightly developed, and the anterior 'costa' forming the front border of the tooth. In the last premolar of *Sivatherium* the median 'costa' is very largely developed, forming the most prominent part on the outer surface; the inner surface of the 'lobe' itself is relatively taller and narrower, with straighter borders. In *H. megacephalum* the 'lobe' of the corresponding tooth is both narrower and higher than the tooth in question, and would alone be sufficient for the distinction of the two species. In the following table the dimensions of the specimen before us are compared with those of the lower jaws of *Sivatherium* and *H. megacephalum* :—

	<i>H. megacephalum</i> .	<i>H. grande</i> .	<i>Sivatherium</i> .
Length of last premolar . . . . .	...	1.7	...
Width „ . . . . .	...	1.1	...
Height „	1.6	1.4	1.72
Length of inner surface of anterior lobe of ditto	1.05	1.3	1.4
„ first true molar	1.85	1.98	2.05
Width „ „	1.3	1.2	1.55
Length of second „	1.87	2.04	2.15
Width „ „	1.35	1.23	1.15
Length of third „	2.64	2.5	2.95
Width „ „	1.25	1.3	1.6
Height „ „	1.7	1.7	2.0(5)
Length of four last teeth . . . . .	...	7.7	...
Depth of jaw at first true molar	2.52	3.7	3.45
„ „ third „	3.3	3.7	4.7

The differences in the form of the specimen indicated by the above dimensions, together with the differences in the structure of the teeth, render it pretty certain that it cannot be referred either to *Sivatherium* or to *Hydaspitherium megacephalum*,

while the size of the specimen, apart from other characters, distinguishes it from the jaw either of *Vishnutherium* or *Bramatherium*. In the flatness of the inner surfaces of the 'lobes' of its molars this specimen corresponds with the upper molars referred to *H. grande*. The two series of teeth further agree in respect of size, and in the relative degree of obliquity of their component parts to the long axis of the jaw. On these grounds the specimen is provisionally referred to the last-named species. The form of this mandible indicates that its owner was a stouter-made animal than *H. megacephalum*, in which respect it is nearer to the sivather.

It may be added that the central enamel pits are very large, and that there are no tubercles in the outer 'valleys,' except in the second 'valley' of the last true molar, where there is a large conical tubercle. Other teeth, probably belonging to the same species seem to indicate some degree of variation in this respect.

Calcaneum.—In figure 1 of plate XVIII of this memoir is represented, of half the natural size, a right calcaneum of a large ruminant, different from the corresponding bone either of *Sivatherium* or of *H. megacephalum*, and presenting considerable resemblances to that of the giraffe. The specimen has lost its posterior apophysis, and is noticeable for its comparative shortness and great vertical depth. Being a deeper bone than the calcaneum of *H. megacephalum*, this specimen would correspond well with the lower jaw referred to *H. grande*, and is accordingly provisionally placed under that species. It should, however, be observed that this specimen differs more from the calcaneum of *H. megacephalum* than does the latter from the corresponding bone of *Sivatherium*, whence there is a possibility of the specimen before us belonging to a distinct genus, to which the so-called *H. grande* may really belong, or which may be new. Other parts of the skeleton are necessary to determine this point. The length of the specimen is 7 inches, and its greatest vertical diameter 3·8 inches.

Proximal phalangeal.—In figure 8 of plate XVII is represented, of half the natural size, the proximal phalangeal bone of a sivatheroid, collected by Mr. Theobald in the Sivaliks of Niki, which may possibly belong to the present species. The bone is relatively shorter and stouter than the proximal phalangeal of *H. megacephalum*, from which it has been thought that it may belong to the present species. It differs also in the form of the inferior condyles; the bone indicates an animal more nearly allied to the *Sivatherium* than to the giraffe.

Distribution.—All the remains provisionally referred to this genus have been obtained from the Sivaliks of the Punjab to the westward of the River Jhelam.

GENUS V: BRAMATHERIUM¹, *Falconer*.

Another genus of four-horned ruminants, of large size, and distinguished from the last by the arrangement of the horns, and containing only a single species.

¹ Brāma, a member of the Hindu trinity, and *Therion*.

As the genus contains only a single species, its history may be given under the head of that species.

Species: *BRAMATHERIUM PERIMENSE*, *Falconer*.

History.—This genus was established in 1845 by Dr. Falconer for the reception of the present species upon the evidence of some upper molar teeth sent to England from Perim Island by Captain Fulljames. The memoir in which these specimens were described appeared in the "Journal of the Geological Society" for 1845, and is reprinted, with the illustrations, in the "Palæontological Memoirs"¹. An appendix was added to this memoir referring to a skull of a four-horned ruminant from Perim Island, which it was suggested might be the same as *Bramatherium*. This skull was described and figured by Mr. Bettington, and a note added by Professor Owen, during the same year², but was not named. In 1876 some lower molars from the same locality were described and figured by myself³. And in 1878 and 1880⁴ it was shown that the cranium noticed above really belonged to *B. perimense*. In plate F. of the "Fauna Antiqua Sivalensis" a considerable number of specimens of broken limb-bones of this species are figured.

Present notice.—No new specimens of the remains of *Bramatherium* have been obtained by the Indian Museum, and the present notice will, therefore, only mention the most important characters of the species.

Cranium.—The cranium figured by Mr. Bettington in the memoir already quoted, is of considerably smaller size than that of *Sivatherium*, and seems to lack the curved nasals so characteristic of that genus. Its most distinctive characters are the horns, which consist of a front pair rising from a conjoint base between the orbits, and of a second pair, also of large size, rising from distinct bases on either side of the occiput. In a former memoir⁵ it was considered that the anterior horns of this genus were homologous with the posterior horns of *Sivatherium*. An examination of a cast of the skull of *Bramatherium*, which had not previously come under my observation, has, however, shown that this view is untenable, and that, as was considered to be the case by Mr. Bettington, the conjoint anterior horns must be homologous with the small separated horns of *Sivatherium*. This view also shows that the conjoint horns of *Hydaspiatherium*, which are clearly the homologues of those of *Bramatherium*, must likewise represent the anterior horns of *Sivatherium*, unless they contain representatives of both pairs of the latter genus. The specimen is too much damaged to permit it to be determined whether a lachrymal vacuity was present.

Teeth and mandible.—The upper molars are sufficiently described in Dr. Falconer's original memoir. As already stated, both the upper and lower molars

¹ Vol. I, p. 391 *et seq.*, pl. 33, figs. 1 to 4. In figure 3 the teeth are represented as if each of their divisions formed a distinct tooth.

² "Journ. Royal Asiatic Society," Vol. VIII, pp. 340 to 417.

³ *Supra*, Vol. I, p. 60, pl. VII, fig. 13.

⁴ *Ibid.*, pp. 160 to 179.

⁵ *Supra*, Vol. I, p. 166.

cannot be generically distinguished from the teeth of *Hydaspitherium*. The mandible is rather stouter than that of *Vishnutherium*, and the lower molars are distinguished from those of the latter genus by the absence of a 'cingulum.' The difference in size is the main point distinguishing the mandible and lower molars from those of *Sivatherium* and *Hydaspitherium*.

Metacarpal and phalangeal.—The only limb-bones referred to this genus which need specific mention here, are an imperfect metacarpal and a proximal phalangeal. A specimen of a lower half of the former bone is represented in figure 5 of plate F of the "Fauna Antiqua Sivalensis," which is the most perfect specimen of a 'cannon-bone' of this genus yet known, the specimens in the Indian Museum being broken off lower down the shaft. As far as can be judged from the broken specimens, this bone appears to have had much the same proportions as the metacarpus of *Hydaspitherium*, but the condyles are separated by a wider interval. A specimen of a proximal phalangeal is represented, of half the natural size, in plate XVII, figure 6 of this memoir. It is of much the same type as the corresponding bone of *Hydaspitherium*. It is probable that the humerus and dorsal vertebra, described on page 207 of the first volume of the "Palæontological Memoirs" by Dr. Falconer as belonging to *Camelopardalis*, really belong to the present species.

Distribution.—Remains of this species have hitherto been recognized only from Perim Island, though it is possible that some of the teeth from the Punjab referred to *Hydaspitherium* may belong to it. The absence hitherto, however, of any remains of sivatheroids in the intermediate district of Sind may possibly indicate that the Perim and Punjab representatives of this group were distinct.

Summary.—The known remains of *Bramatherium* indicate that it was a four-horned ruminant resembling the hydaspithere in this point and in its length of limb.

GENUS VI: SIVATHERIUM¹, *Falc. and Caut.*

Four-horned ruminants, with each horn, or antler, arising from a distinct base, the anterior horns simple, and the posterior palmate. As the genus includes only one species, its history may be given under that head.

Species: SIVATHERIUM GIGANTEUM, *Falconer and Cautley*.

History.—The first notice of the remains of this giant among ruminants appears to be one by the late Sir W. E. (then Lieutenant) Baker, on an antler and some cervical vertebrae of a large ruminant from the Siwaliks, described as belonging to a species of elk². This paper was published in September 1835, and the specimens therein described, which are now in the Indian Museum, were subsequently catalogued by Dr. Falconer as belonging to his *Sivatherium*. In October in the same year, a letter was communicated to the Asiatic Society of Bengal from Sir

¹ Siva (or properly Shiva), one of the Hindu trinity, and *Therion*.

² "J. A. S. B.," Vol. IV, p. 506, pl. XLIV.

P. T. Cautley¹, in which the name *Sivatherium* is incidentally mentioned, apparently for the first time. In 1836 a memoir on this genus, with illustrations, appeared both in the "Asiatic Researches"² and in the "Journal of the Asiatic Society of Bengal"³.

In 1837 Colonel Colvin communicated a note, with illustrations, on an occiput and lower jaw of the *Sivatherium*⁴.

In 1839 the original skull described by Messrs. Falconer and Cautley, together with the last-mentioned lower jaw, was again figured by Dr. Royle⁵.

In his "Odontography," published between 1840 and 1845, Professor Owen makes a few remarks on the teeth of *Sivatherium*, and figured the last lower true molar (pl. cxxxi, fig. 3).

In the "Fauna Antiqua Sivalensis," the bones of the skull and the greater part of the skeleton are figured in plates xci, and xcii a, b, c, and d.

In 1859 a considerable number of remains of *Sivatherium* were described by Dr. Falconer in his "Catalogue of the Siwalik collections of the Asiatic Society of Bengal."

In 1862 Professor Gaudry showed⁶ that a skull assigned by Falconer and Cautley to the female of *Sivatherium*, belonged to the allied genus *Helladotherium*.

In 1862, the late Dr. Murchison published the "Palæontological Memoirs" which contains a reprint with illustrations of Dr. Falconer's papers, and also an appendix published for the first time (vol. I, p. 266). This appendix contains a description of the specimen of the occiput described by Colonel Colvin and of numerous bones.

In 1871, Professor Murie published an elaborate memoir on the present genus⁷ with restored figures of the skeleton and of the complete animal.

In the previous volume of this work there are various incidental allusions to *Sivatherium giganteum*, and an upper true molar is represented in figure 3 of plate XXVII. The above are all the original notices of this species of any importance with which I am acquainted.

Object of present notice.—The Siwalik collection of the Indian Museum contains comparatively few remains of *Sivatherium*, since that genus does not seem to occur in the Siwaliks either of the western Punjab or of Sind, from which districts by far the greater portion of the collection was obtained. There are, therefore, but few new specimens of any importance to describe, and indeed, the memoirs of Dr. Falconer on this subject are so full and accurate that little remains to be added to them. The present notice will, therefore, be confined to some brief remarks on various portions of the skeleton and on the serial position of the genus, in the latter

¹ "J. A. S. B.," Vol. IV., p. 585 *et seq.*

² Vol. XIX, p. 1.

³ "J. A. S. B.," Vol. V, p. 38, pl. I.

⁴ 6. *Ibid.*, Vol. VI, p. 152, pls. VIII, IX.

⁵ "Illustrations of the Botany, etc., of the Himalayan Mountains," Vol. II, pl. VI.

⁶ "Animaux Fossiles et Géologie de l'Attique," p. 260.

⁷ "Geol. Mag.," Vol. VIII, p. 438, pls. XII, XIII.

of which points my own opinion differ considerably from those of previous writers. Figures have been given of a few of the molars, of a cervical vertebra, and (on a reduced scale) of the 'cannon-bones' and a phalangeal.

Upper molars.—In figure 1 of Plate XXI, the left upper true molar of *Sivatherium giganteum* figured in the first volume of this work, has been redrawn and lithographed in order to facilitate comparison with the molars of *Vishnautherium* and *Hydaspietherium*. The tooth is an isolated specimen, collected by Mr. Theobald in the Siwaliks of the Kangra district, and from its presenting disks of pressure both on the preaxial and postaxial surfaces, must be either the first or second true molar. The tooth is not so large as some other specimens, but exhibits well the points characteristic of the genus. The most distinguishing point is the great development of the 'costæ' on the external surface, sections of which are exhibited on the worn masticating surface shown in the figure. The 'lobes' are oblique to the long axis of the crown in only a small degree. The central enamel pits are extremely deep, and the enamel very rugose. A peculiar character is the presence of a projection from the preaxial surfaces of both the hinder 'lobe' and 'crescent' projecting in front of the postero-external angles of the anterior 'lobe' and 'crescent.' These projections appear to be constant in all specimens of the upper molars, and are unknown in other genera. There is no trace of a 'cingulum' on the inner aspect of the 'crescents,' but there is a minute tubercle placed high up in the 'median valley' and attached to the anterior crescent.

A very fine specimen of the anterior upper molars of the left side is contained in the collection of the Royal College of Surgeons, of which we have a cast in the Indian Museum (No. B. 361). The teeth shown are the third and fourth premolars and the last true molar, the latter being rather larger than the specimen figured here. The premolars are remarkable for their enormous absolute and relative size. The following table gives the dimensions of these teeth, and of the specimen figured here, which is arbitrarily taken as a first true molar:—

Length of 3rd premolar	. . . . .	1.96
Width " "	. . . . .	2.08
Length 4th "	. . . . .	1.6
Width " "	. . . . .	2.2
Length 1st true molar	. . . . .	2.04—2.2
Width " "	. . . . .	2.1—2.2

Mandible.—The mandible, of which a left ramus is figured in plate XXI, figure 1, of the first volume of the "Palæontological Memoirs," has been already noticed, and its measurements given in describing the lower jaw of *Hydaspietherium megacephalum*. The characteristic points of this jaw are its great size, its great depth, and the well-marked 'costæ' on the inner surfaces of the molars. In treating of the last lower true molar of this jaw, Professor Owen observes¹ that the third lobe "presents in the *Megaceros* and *Sivatherium* a deeper central enamel island or fold, which also characterises the smaller third lobe in the Giraffe."

¹ "Odontography," p. 335, and note.

Milk-molars.—There is a specimen of a maxilla with the upper milk-molars of *Sivatherium* in the British Museum, of which the Indian Museum has a cast; these teeth are so like the upper molars in structure that they have not been figured.

A specimen of the left lower milk-molar dentition is represented in figure 3 of plate XXI of this memoir. These teeth are implanted in a portion of the mandible, which also shows the anterior half of the first true molar. The milk-teeth exhibited are the third and fourth molars. The specimen was obtained by the Indian Museum through an exchange with the Rûrki Museum, and was obtained from the Siwaliks in the neighbourhood of the Ganges Valley. The penultimate milk-molar is remarkable for its exceptionally complete development, its hinder half consisting of a distinct 'crescent' and 'lobe,' and the fore half of a 'crescent' with highly developed angles. The third milk-molar is divided into three complete sections, each containing a 'crescent' and a 'lobe,' and with a well-marked tubercle in each of the 'valleys' on the outer side. It closely resembles, on a larger scale, the corresponding milk-molars of the Siwalik giraffe (pl. XVI, fig. 8) and of the hydasphithere (pl. xxi, fig. 4). It is indeed probable, if not certain, that if these three teeth had been found apart from any other remains, they would be referred to three species of the same genus. The dimensions of the young jaw and milk-teeth of *Sivatherium* are as follows:—

Depth of jaw at last milk-molar	27
Length of penultimate milk-molar	11
„ last milk-molar	212

Cervical vertebra.—The specimen of the sixth cervical vertebra represented in plate XXII, was obtained by the Indian Museum through an exchange with the Museum at Rûrki, near which place it was obtained. It is figured as being the most perfect specimen that I have seen; it is of enormous size, and exhibits the characteristic shortness of the 'centrum,' and of the vertebrarterial canal. Its dimensions are as follows:—

Length of centrum superiorly	43
Vertical diameter of condyle	33
Length of bar of transverse process	21

This vertebra indicates an animal with a length of neck about proportional to that of the oxen.

Metacarpus.—In figure 1 of plate XVII of this memoir is figured a complete metacarpal of *Sivatherium giganteum*, from a specimen in the British Museum from the Siwaliks, the dimensions of which are as follows:—

Extreme length	137
Breadth of proximal extremity	47
„ distal	47
„ a single condyle	22

The bone is of great stoutness, and much expanded laterally, in which respects it differs from the 'cannon-bones' of the other sivatheroids figured in the same plate. Its proportions are much the same as the metacarpals of the larger kinds of cattle,

but the bone is somewhat shorter and thicker. Another specimen described by Dr. Falconer¹ has the following dimensions :—

Extreme length	. . . . .	13.0
Breadth of proximal extremity	. . . . .	4.3
" distal "	. . . . .	4.3

A third imperfect specimen² has the breadth of the head measuring 4.8 inches. These three specimens show that there is but little variation in the size of this bone.

Metatarsus.—In figure 2 of plate XVII of this memoir there is represented, on a small scale, the metatarsal of a large ruminant, copied from plate F., figure 12 of the "Fauna Antiqua Sivalensis," where it is assigned to *Sivatherium giganteum*. It has the following dimensions, viz. :—

Extreme length	. . . . .	16.4
Breadth of proximal extremity	. . . . .	3.8
" distal "	. . . . .	4.0

These dimensions show that this metatarsus is nearly three inches longer than the metacarpus, which is a vastly greater difference than occurs between the length of the fore and hind 'cannon-bones' of allied ruminants (see these bones of *Helladotherium* in figures 4 and 5 of same plate), and it therefore appears to me very doubtful whether this bone really belongs to *Sivatherium*, and whether it may not rather have belonged to one of the species of *Hydaspitherium*. I do not, therefore, take this specimen as a standard of comparison for the length of the hind limb of this genus.

Calcaneum.—An imperfect specimen of the calcaneum is represented in figure 12 of plate D. of the "Fauna Antiqua Sivalensis." This bone is mentioned here because the sharply produced ridge on the superior surface of the fore part of the projecting portion, indicates affinity with the deer and oxen instead of with the giraffe, and *Hydaspitherium*.

Proximal phalangeal.—A very fine specimen of one of the proximal phalangeals of the (probably) hind foot is represented, of half the natural size, in plate XVII, figure 9 of this volume. The specimen is figured in order to illustrate the extreme strength and stoutness of the limbs of the sivathere; it was obtained by Mr. Theobald in the Siwaliks of the Kangra district. Its great difference from the corresponding bones of the allied genera is sufficiently indicated by the illustrations.

Nature of the horns.—The sivathere, as already said, was provided with two pairs of horns, the anterior of which are simple cones, while the posterior are broad and palmate, much like the antlers of the elk, for which they were taken by their original describer. The four-horned antelope of India, *Tetraceros*, shows that the branched horns correspond to the horns and antlers of the oxen and deer, but with regard to the nature of these horns, and especially of the hinder pair, there has been considerable discussion. The anterior horns were considered by Dr. Falconer to have been coated with a horny sheath like those of the antelopes, and it appears

¹ "Pal. Mem.," Vol. I, p. 277, No. 346.

² *Ibid.*, No. 345.

to me that such was very possibly the case, unless they were covered merely by skin, as in the giraffe.

With regard to the posterior horns, Dr. Falconer¹ remarked that they are branched and palmated as in the deer, but that they have no 'burr,' and that they are hollow at the base, a combination of characters not found in any cervine antlers. He concludes that they "were at least three-branched and at the same time caviorned."

Dr. Murie comes to the conclusion that the hinder horns most nearly resembled those of the American prong-buck (*Antilocapra*), being probably provided with separate horny sheaths on the points, connected by a common hairy covering. He concludes that this horn was endued "with certain external aspects peculiar to those of deer; a horn likewise possessing attributes belonging to antelopes and the *Bovide*; a horn differing in every respect from that of the caméléopards" (*sic*.)

Now, without committing myself to Dr. Murie's views as to the presence or absence of a distinct horny covering, it appears to me, as admitted by Dr. Murie, that there is a very considerable affinity to the structure of the cervine antler in the horns of the *Sivatherium*. This is especially manifest in the specimen figured by Sir W. E. Baker, which in the form of the large grooves for blood-vessels most strikingly resembles the antler of the so-called Irish elk (*Megaceros*). It appears to me probable that the horns of the sivathere were of a kind of generalised type between an antler and a sheathed horn.

Position of the genus and its allies.—In concluding his memoir, Dr. Murie came to the conclusion that the sivathere must be placed in a distinct family, and that it showed affinities with several distinct groups of ruminants, but that it was on the whole most nearly allied to *Antilocapra*. He admits that it presents some affinity to the deer, but says that its only affinity with the giraffe (which is rightly termed a "modified deer") is in the structure of its molar teeth. By a most unaccountable oversight Dr. Murie entirely omits all mention of the genus *Helladotherium* which had been long previously described by M. Gaudry as a genus connecting the giraffe with the sivathere.

I shall now proceed to show how my views on this subject differ from those of Dr. Murie. In the first place it may, I think, be taken for granted that no one would question the very intimate relationship existing between *Sivatherium*, *Bramatherium*, and *Hydaspiatherium*, and we have already seen that the teeth of the two last-named genera cannot be distinguished from those of *Helladotherium*, which were originally described as belonging to *Camelopardalis*, while the skull was described as the female *Sivatherium*. Further, in no ruminants, except those of the group under consideration, the giraffe, the Irish elk, the true elk, and some of the other deer, are the 'lobes' of the molars placed obliquely to the long axis of the teeth so as to overlap one another, while their enamel has a peculiar rugose structure, most marked in the sivathere, and least so in the round-antlered deer. In

¹ "Pal. Mem.," Vol. I, p. 268.

Antilocapra and all cavicorn ruminants on the other hand, the enamel of the molars is nearly smooth, and their 'lobes' are always set in the same antero-posterior line so as never to overlap.

The above points appear to me to indicate a very intimate connection between the sivatheroids and the giraffe, and thus with the deer. Dr. Murie's main objection against the connection of the sivathere with the giraffe appears to be the length of limb of the former, but this we have shown to be bridged over by intermediate forms.

In regard to the deer Dr. Murie remarks: "The *Sivatherium*, again, is no deer, inasmuch as the fossil skull shows no supra or ant-orbital [lachrymal] fissures." Now, in *Hydaspitherium* (as is well shown in the figure of the skull in the first volume) there is a very large lachrymal fissure, as in the deer and the giraffe. One of the allies of *Sivatherium* is, therefore, in this respect, *very closely related to the latter animals, and distinguished from all other ruminants*. Dr. Murie then remarks that the back and base of the skull and the form of the lower jaw do show certain cervine affinities. The horns appear to me to be as near to the antlers of the deer as to the horns of the antelopes.

Finally, with the evidence at present before us, it appears to me, as stated in the early part of this memoir, to be necessary to group the sivathere and its allies in the same family as the giraffe, and that this family should occupy the next place to that of the Cervide, the elk and the vishnuthere being probably the two genera which most closely allied the members of the two families.

Distribution.—Remains of the *Sivatherium* have hitherto been only obtained from the Siwaliks of the Sub-Himalayan ranges, being extremely common in the neighbourhood of the Jamna valley, and becoming gradually rarer as we advance to the north-west, and being unknown beyond the Jhelum river.

UNDETERMINED TEETH.

On pages 88 and 89 of my oft-quoted notice in the eleventh volume of the "Records" a fragment of a lower jaw was described containing two teeth, which were classed as the second and third (penultimate) premolars. The larger of these teeth is almost precisely similar in form to the third lower milk-molar provisionally assigned to *Hydaspitherium megacephalum*, but is of considerably larger size. From this similarity in form it would at first appear that these teeth must be milk-molars, but the anterior lower milk-molars of the giraffe so much resemble the milk-molars that even this identification would be rash.

If these teeth be milk-molars, it would seem that they do not belong either to *Sivatherium* or to *Hydaspitherium*, since we have referred other milk-molars to those forms. They are certainly not the premolars of either of those genera, which are known. They are too large to belong to *Camelopardalis*. If they be premolars, they might possibly belong to *Vishnutherium* or *Bramatherium*, though they would seem to be too large to be the milk-molars of those forms. The length of the

penultimate tooth (milk-molar or premolar) is 1.4 inches; that of the smaller, 0.96 inch.

In figure 4 of plate XVI of this memoir is figured a lower tooth which is the second (anti-penultimate) of either the milk-molar or premolar series. It was obtained by Mr. Theobald in the Siwaliks of the Punjab, and is noticed on pages 89 and 90 of the notice in the eleventh volume of the "Records." It cannot be generically determined, but belongs to some member of the present family. The tooth posteriorly has a simple oval pit on its summit, extending about one-third of its length; anteriorly it has a simple trenchant edge.

List of the more important recent memoirs and notices bearing on the Osteology and Palæontology of the Camelopardalidæ, consulted in the writing of the foregoing memoir.

BAKER, W. E.

"On the Fossil Elk of the Himalaya." "J. A. S. B.," Volume IV, p. 506. (Horn and cervical vertebra of *Sivatherium* described and figured under above name.)

BETTINGTON, A.

"Memorandum on certain Fossils, more particularly a new Ruminant, found at the Island of Perim, in the Gulf of Cambay." "Jour. Royal Asiatic Society," 1845, page 340. Note on same by Professor Owen, page 417. (Skull of *Bramatherium perimense* described and figured.)

CAUTLEY, P. T.

Letter from, regarding Sewalik Fossils. "J. A. S. B.," Volume IV, page 585 *et seq.* (First mention of *Sivatherium*.)

"Note on a Fossil Ruminant Genus allied to Giraffidæ, in the Sewalik hills." "J. A. S. B.," Volume VII, p. 658.

COLVIE, E.

"Additional Fragments of the Sivatherium." "J. A. S. B.," Volume VI, page 152, Plates VIII and IX. (Occiput and mandible figured.)

DUVERNOY, E.

"Sur une mâchoire de girafe fossile découverte à Issoudun." "Notes communiquées à l'Acad. des Sciences." May 15th and November 27th, 1843. (*Camelopardalis biturigum*.)

FALCONER, H.

"Description of some Fossil Remains of Dinotherium, Giraffe, and other Mammalia from Perim Island, Gulf of Cambay, Western Coast of India." "Q. J. G. S.," Volume I, page 356. "Pal. Mem.," Volume I, page 391. (*Bramatherium*.)

FALCONER, H., and CAUTLEY, P. T.

"Fauna Antiqua Sivalensis." London, 1846-9.

FALCONER, H., and CAUTLEY, P. T.

"On some Fossil Remains of Anoplotherium and Giraffe, from the Sewalik Hills." "P. G. S.," No. 98. "Pal. Mem.," Vol. I, p. 190.

"Sivatherium Giganteum, a new Fossil Ruminant Genus, from the valley of the Markanda, in the Sewalik branch of the Sub-Himalayan mountains." "Asiatic Researches," Vol. XIX, p. 1. "J. A. S. B.," Vol. V, p. 38. "Pal. Mem.," Vol. I, p. 247.

FALCONER, H., and WALKER, H.

"Catalogue of Fossil Remains of Vertebrata in Museum of A. S. B." Calcutta, 1859.

GAUDRY, A.

"Animaux Fossiles et Géologie de l'Attique." Paris, 1862. (*Camelopardalis attica* and *Helladotherium duvernoyi*.)

LEIDY, J.

Notice of *Mesacercops coloradensis*. "Pro. Acad. Sci. Philad.," January 4th, 1870.

LYDEKKER, R.

"Fossil Mammalian Faunæ of India and Burma." "R. G. S. I.," Vol. IX (*Camelopardalis sivalensis*) (p. 104); *Vishnutherium iravadicum* (p. 103); *Hydaspietherium megacephalum* (p. 154).

"Notices of Siwalik Mammalia." (*Camelopardalis* and *Hydaspietherium*.) "R. G. S. I.," Vol. XI, p. 83.

"Palæontologia Indica," Ser. X, Vol. I. (*Camelopardalis sivalensis*; *Vishnutherium iravadicum*; *Bramatherium perimense*; and *Hydaspietherium megacephalum*.)

MEYER, H.—

"Über die fossilen Reste von Wirbelthieren welche die Herren von Schlagintweit von ihren Reisen in Indien und Hoch-Asien mitgebracht haben," "Paläontographica," Vol. XV, p. 29. (Teeth of giraffe (?) from Nurpur figured.)

MURCHISON, C.—

"The Palæontological Memoirs and Notes of the late Hugh Falconer." London, 1868.

MURIE, J.—

"On the Systematic Position of the *Sivatherium Giganteum* of Falconer and Cautley." "Geol. Mag.," Vol. VIII, p. 438.

OWEN, R.—

"Odontography." London, 1840-45.

"On the Anatomy of Vertebrates." London, 1866, Vols. II and III.

ROYLE, J. F.—

"Illustrations of the Botany and other Branches of the Natural History of the Himalayan Mountains." London, 1839. (Occiput and mandible of *Sivatherium* figured.)

WAGNER, A.—

"Nachträge zur Kenntniss der fossilen Huft-thier Ueberreste von Pikermi." "Sitz. d. kön. baer. Akad. d. Wissens." 1861, 13th July, p. 78 and plate. (*Orasius eximius* and *Camelopardalis vetusta*.)

POSTSCRIPT.

Position of sivathere.—Since the above was in the press a memoir by Professor Rüttimeyer¹ on the cervine family has reached me, having a considerable bearing on the matters discussed above regarding the classification of the giraffe and its allies. In that memoir the giraffe is classed among the group Cervina, and placed next the elk, through which it is connected with the reindeer, and thus with the true stags. The molar dentition is shown to be nearer that of the elk than of any other

¹ "Beiträge zu einer naturlichen Geschichte der Hirschfamilie." "Abhand. d. Schweiz. pal. Gesell.," Vols. VII, VIII, 1880-81.

living mammal, while the elongated parietals, large lachrymal vacuities, and the air-cavities in the cranium are shown to be true cervine characters. Its so-called horns are distinguished from the antlers of the deer by their development during fœtal life, and by their non-deciduous character, and are thus shown to form an intermediate grade between true antlers and true horns; their presence in both sexes is a character they possess in common with the antlers of the reindeer. *Helladotherium* is considered to be closely allied to the giraffe, and it is suggested that the male may have had horns or antlers, the specimens with which we are acquainted being all females.

So far the views propounded by Professor Rüttimeyer are in perfect accord with those expressed above; but in regard to the systematic position of the other mammals treated of here, his views differ very widely from them. *Sivatherium* and *Hydaspthierium* (and hence *Bramatherium*¹ and presumably *Vishnutherium*) are entirely separated from *Helladotherium* and the giraffe, and are classed with the antelopes, the *Damalis* group of South Africa being considered their nearest allies. The main grounds of this association appears to be the shortening of the parietal zone of *Sivatherium* and *Hydaspthierium*, which is a character not found in the deer family, but one common to the oxen and certain antelopes (*e. g.*, the gnu). The close similarity of the molars of all the animals classed above as the *Camelopardalidæ*—a similarity not only of external form, but also of minute structure—is disregarded. This similarity, as is clearly pointed out above, is so close that the teeth of *Helladotherium* cannot possibly be distinguished from those of *Hydaspthierium* and *Bramatherium*, while a skull now referred to the first of these three genera was referred both by Falconer and Murie to a female *Sivatherium*. Further, the transition in the bones of the limbs and neck from *Sivatherium* to the giraffe, the presence of lachrymal vacuities in the giraffe and *Hydaspthierium* as well as other characters, appears to afford conclusive argument as to the intimate relationship of all these animals. It should not be considered a matter of wonder if the diverging extremes of this group are found to present certain characters which are essentially those of the families with which they respectively nosculate. On the contrary, the presence of such characters are in perfect accord with what we should *à priori* expect to meet with in a family which is confessedly a connecting link between two families now widely separated.

Last lower molar of Bramatherium.—Among some Siwalik specimens in the Museum of Trinity College, Dublin, which Professor V. Ball has kindly given me an opportunity of examining, is the hinder portion of the right ramus of the mandible of a large ruminant from Perim Island, containing the last true molar. The specimen was presented by Colonel Montgomery. The form of the tooth shows that it belonged to a sivatheroid, and its size, and the locality whence it was obtained, lead to the inference that it should probably be referred to *Bramatherium perimense*, of which the last lower molar was previously unknown. The tooth is in an interme-

¹ Professor Rüttimeyer (*loc. cit.*) errs in stating that the skull of *Bramatherium* is unknown.

diate stage of wear, and is somewhat damaged; as far as can be judged, it appears to have had the 'costæ' but slightly developed, as in *Hydaspitherium*; its crown seems, however, lower; and the tooth is marked by the great development of the 'lobe' of the 'accessory column.' In the following table the dimensions of this specimen are compared with the corresponding dimensions of those of four other members of the family, taken from the foregoing memoir:—

	Camelopardalis.	Bramatherium.	Hydasp. megaceph.	Hydasp. grande.	Sivatherium.
Length of last molar	1.75	2.15	2.64	2.5	2.95
Depth of jaw at „	1.75	2.8	3.3	3.7	4.7

These dimensions show that the hinder part of the lower jaw of *Bramatherium* was more slender than that of *Hydaspitherium*, and thereby approached the giraffe and the visnuthere. The middle part of the jaw of *Bramatherium*, of which the dimensions are given on page 61 of the first volume of this work, shows a smaller depth than the jaw of *H. megacephalum*, and we may therefore conclude that the lower jaw of *Bramatherium* was slighter than that of the narrow-jawed hydaspithere, to which, however, the teeth most nearly approximate. There is no 'cingulum' in the lower molar of *Bramatherium*, nor any tubercles in any of the valleys on the outer side.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK SELENODONT SUINA, ETC.

By R. LYDEKKER, B.A., F.Z.S.,

GEOLOGICAL SURVEY OF INDIA.

(WITH PLATES XXIII. TO XXV.)

ORDER : UNGULATA ; DIVISION : ARTIODACTYLA ;

SECTION : SUINA SELENODONTIA.

Introductory.—The extensive and important group of pig-like Artiodactyle Ungulata, commonly classed together under the head of Suina, may conveniently be divided into two subordinate groups, distinguished from each other by the structure of their molar teeth. The first of these groups may be termed the Bunodontia,¹ and is characterised by having the cusps, or columns, on the grinding surfaces of the upper molar teeth arranged either in an irregular manner, as in the common pig, or with a more or less distinct tendency to the production of larger columns at the four angles of the crown as in *Tetraconodon*²: this group comprehends the hippopotamus, and all living pig-like animals, as well as the extinct *Hyotherium*, *Entelodon* (*Elotherium*), and their allies. The second group, forming the main subject of the present memoir, may be termed the Suina Selenodontia,³ and is characterised by the upper molars having their inner pair of cusps, or columns, of a more or less distinctly crescent shape. This second group is now totally extinct, and is represented by *Chæropotamus*, *Hyopotamus*, *Oreodon*, and a host of kindred forms. As is nearly always the case in a large group of animals, there is always a difficulty in referring all the forms to their respective sub-division, and this is exemplified in genera like *Chæropotamus*, and some species of *Anthracootherium*, which, though belonging to the selenodont group, yet afford an easy transition from its most typical members, like *Oreodon*, to some of the more specialized of the bunodont group, like *Tetraconodon*.

¹ From *bounas*, a hillock, and *odous*, a tooth.

² *Vid. sup.*, Vol. I., pl. X.

³ From *seleno*, the moon, and *odous*.

In the present memoir numerous remains belonging to various hitherto undescribed forms of the selenodont group, are figured and described, while, in addition brief notices are given of such members of the group as have been previously described from the tertiaries of India. It will be found that by far the greater number of these specimens have been obtained, by the exertions of Messrs. W. T. Blanford and F. Fedden, of the Geological Survey of India, from the lower Manchhar (Siwalik) rocks of Sind and the districts to the northward.

It will further be observed that the genera are identical with, or closely allied to those of the European oligocene and miocene; the later genera characteristic of the sub-Himalayan deposits being in the main absent. These differences indicate that the mammalian fauna of the lower Manchhars of Sind belongs to a lower horizon than that of the sub-Himalayan Siwaliks. According to the latest researches 'it seems probable that the fauna of the lower Manchhars should be relegated 'to the early pliocene time,' while that of the sub-Himalayan Siwaliks, which are on the same horizon as the upper Manchhars of Sind, belongs to a later period of the same epoch; there being a probability of the higher beds of the former reaching up into the pleistocene. In the present and succeeding memoirs the age of the lower Manchhars will be alluded to as 'earlier pliocene,' and the sub-Himalayan Siwaliks as 'higher pliocene.'² It may be added that such of the older Sind mammalian genera as are found in the sub-Himalayan strata (and only one of those described here is so found) may either be later survivals, or may have come from a lower horizon (Náhan) than the majority of the fossils.

The majority of the remains described in this memoir consist only of detached molar teeth, which are often the sole evidence on which a genus or species is founded. The publication of the present memoir has purposely been delayed for a considerable period in the hope that additional remains of the more obscure forms might be obtained, but as the geological exploration of Sind is unlikely to be continued for the present, the time has come when such remains as are sufficiently identifiable should be laid before the scientific world.

Reverting to the selenodont Suina as a whole, it would seem probable that this group should again be divided into three minor sub-divisions. The first of these is distinguished by the crowns of the upper molars being furnished with five columns, or cusps, and may accordingly be termed the pentecuspidate division (Pentecuspidati). It probably comprehends at least two families; to the best known of which belongs the well-known genus *Hyopotamus*. For this family Dr. W. Kowalevsky, in his classical memoirs on its osteology,³ has adopted the name

¹ See Duncan, 'Quar. Jour. Geol. Soc.,' Vol. XXXVII., p. 207, *et seq.*

² These unsymmetrical terms are used in preference to 'upper and lower' or 'earlier and later pliocene,' as both the latter have acquired a fixed signification as indicating definite stages of the pliocene epoch, whereas the idea to be conveyed here is merely that the sub-Himalayan Siwaliks are higher up in the pliocene than the Lower Manchhars.

³ 'Phil. Trans.,' 1873, p. 19, *et. seq.* 'Palæontographica,' Vol. XXII., parts 3-5.

Hyopotamidae, in place of the older name *Anthracotheridae*: as, however, it will be shown in the sequel that there is a strong probability that the genus *Hyopotamus* will eventually have to be united with *Anthracotherium*, the older name *Anthracotheridae* will be employed here. There is a further advantage in using the term *Anthracotheridae* for the family name, because Dr. Kowalevsky seems to include under his family such widely-divergent forms as *Anthracotherium* and *Anoplotherium*, an extension of the family which, as Dr. H. Filhol, in his exhaustive memoir on the hyopotamids of Ronzon,¹ has shown is not advisable for general adoption. The Indian representatives of the family include the genera *Anthracotherium* and *Hyopotamus*. The second family is represented by *Miototherium* of the Quercy phosphorites, but there may be some doubt as to its position here. The genus *Diplopus* (included by Dr. Kowalevsky in the *Hyopotamidae*), of which the teeth and skull are unknown, may form a third family of this division. The second division of the selenodont Suina is characterised by the crowns of the upper molars carrying only four columns on their masticating surface, and may be termed the tetracuspitate division (Tetracuspidiati.) It comprehends the families *Merycopotamidae* and *Oreodontidae*, both of which have Indian representatives. The third division of the selenodont Suina comprises the family *Anoplotheridae*, and may be termed the *Anoplotherina*: it is, however, not impossible that this division should be merged with the second.

As we have already observed, the affinity of the selenodont Suina to the bunodont pigs is so close that there is sometimes a difficulty in assigning certain forms to their proper positions. On the other hand, the selenodont Suina are so intimately connected with the true ruminants, that here also it is frequently difficult to draw a satisfactory line of distinction. Thus certain of the hyopotamids pass insensibly into the genus *Cainotherium*, which is undoubtedly a true ruminant genus; the oreodons are closely allied to, if not the direct progenitors of, the ancestors of the camel (*Procamelus*, etc.); and the anoplotheres are as intimately related to the ruminant xiphiodonts. While, therefore, for the purposes of classification it is convenient to retain the groups Suina (with its three sub-divisions) and Ruminantia,² it is highly probable that there is such a complete transition between them that they cannot logically be maintained. It is probable that many of the forms treated of here are not the true ancestors of the ruminants, but should rather be looked upon in the light of cousins descended from a common stock.

Whether any or all of the animals classed here as the Suina Selenodontia were endowed with the power of rumination, and their internal economy modified in accordance with that function, is a question which cannot ever be certainly determined. The oreodons have, however, been termed 'ruminating hogs,' and from the close similarity of the structure of the molars of these and allied forms to

¹ "Étude des Mammifères Fossiles de Ronzon." 'Ann. d. Sci. Nat.' 1881. Vol. XII., Art. No. 3, p. 89 (reprint).

² In former parts of this work the term Selenodontia has been applied to the true ruminants, but it has been thought best for the future to confine it to the selenodont Suina.

those of the true ruminants, it is highly probable that the more specialized forms of the group were endowed with the ruminating function, while in the less specialized forms this function was absent.¹ If this be so it is evident that the more specialized forms must have been at least as closely related to the true ruminants as to the bunodonts, although the oreodons are so connected by *Merycopotamus* with the hippopotamus and the pigs as to clearly form one group, and it, therefore, confirms our conclusion as to the intimate relationship existing between the pigs and the true ruminants.

It may be affirmed with more certainty that the food of the higher selenodont pigs consisted in great part of leaves and grass (which require finer trituration, and consequently a more complex form of molar, as is exemplified in the ruminants, horses, and elephants), while their bunodont allies feed, as we know, more generally on roots and tubers, and occasionally on animal matter. Hence it is probable that the muzzles of most of the selenodonts were less elongated than in the true pigs, which require to turn up the soil to obtain their nutriment.

It must further be observed that certain peculiar and little-known animals (*Celochærus*) have been described from the Quercy phosphorites,² the molar teeth of which closely resemble those of the bunodont pigs, while the skulls show certain affinities to those of the simiine Primates, and it is highly probable that these animals are related both to the monkeys and the pigs. They have been referred to a group termed Pachysimia, but it is doubtful whether this should be placed among the Primates or the Artiodactyla.

In the following table a provisional scheme for the classification of the best-known families and genera of the Suina is given, and the relationship of the section to the Ruminantia and Pachysimia is also indicated, but the position of the latter section in the Artiodactyla must only be considered provisional. The genus *Listriodon* is purposely omitted, and referred to the perissodactyles; if, however, it really be an artiodactyle, it should probably form a separate family of the Bunodontia. *Hippohyus* is only provisionally referred to the family *Suidæ*, as its molars exhibit a more specialized structure than those of the other members, and it should perhaps be raised to the rank of a distinct family. It has not been found practicable to indicate in the table all the relationships of the different families to one another; thus the relationship of *Hippopotamus* to *Merycopotamus* is not apparent; and while the former genus is placed nearest to the Pachysimia, the relationship of that group is evidently nearer to *Hyotherium* and *Acotherulum*. Many of the American, and other, genera are omitted, on account of the difficulty of assigning them to their proper positions.

¹ Professor Gaudry ("Les Enchaînements du Monde Animal") classes the oreodons as true ruminants, but *Hyopotamus* and *Merycopotamus* as Suina.

² Filhol "Recherches sur Les Phosphorites du Quercy." "Ann. d. Sci. Nat.," Vol. VII. (reprint), 1878, p. 327.

I. SUINA.

A.—BUNODONTIA.		B.—SELENODONTIA.		
1. Suidae . . .	<i>Sus</i> , <i>Porcula</i> . <i>Bohirus</i> , <i>Hippohys</i> (?), <i>Santharium</i> , <i>Amphidacturus</i> , <i>Heterohys</i> , <i>Chapanarua</i> , <i>Tetracodon</i> , <i>Exochernis</i> .	a. PENTACUSPIDATI.	b. TETRACUSPIDATI.	c. ANOPIOTHERIA.
		1. Anthracotheriidae. <i>Anthracotherium</i> , <i>Hypotamus</i> , <i>Elaphotherium</i> , <i>Choropotamus</i> , <i>Hemicherus</i> .	1. Merycopotamidæ <i>Merycopotamus</i> , <i>Sitomeryx</i> .	Anoplotheriidae— <i>Anoplotherium</i> , <i>Eurytherium</i> , etc.
2. Dicotylidae . . .	<i>Dicotyles</i> , <i>Heterotherium</i> (?), <i>Tritichys</i> , <i>Patigonus</i> .			
3. Acotheriidae . . .	<i>Aotheridium</i> , <i>Leptaetheridium</i> .			
4. Phacotheriidae . . .	<i>Phacotherium</i> .			
5. Entelodontidae . . .	<i>Entelodon</i> , <i>Tetracodon</i> , <i>Achanodon</i> .		2. Orvodontidae . . . <i>Diplogus</i> .	<i>Orvodon</i> , <i>Epyrondon</i> , <i>Agricotherium</i> , <i>Merycotherium</i> .
6. Hippopotamidæ . . .	<i>Hippopotamus</i> , <i>Cheropsis</i> .			
?	<i>Leptotherium</i> , <i>Parahys</i> , <i>Eolys</i> , <i>Udalyus</i> .			

II. PACHYSIMIA.

Cebodoriidae—*Cebodorus*.

(This group may belong to the Primates, but in any case it connects that order with the Bunodont pigs.)

III. RUMINANTIA.

Includes all the ruminants connected by *Yachodon* and *Dicladon* with *Asoploterium*, and by *Coinotherium* with *Hypotamias* and other selenodont Suina.

The arrangement of the families in the foregoing table must be considered merely as provisional and liable to considerable future alterations, and it is probable that many of the genera included under one family should be referred to distinct families. Thus the family *Anthracotheridæ* is considered by Dr. Filhol to include only the genera *Anthracotherium* and *Hyopotamus*, and it is suggested that even these might possibly belong to two families. On the contrary, Dr. Kowalevsky would include many more genera than those given in the table, under the same heading. Again the genus *Acotherulum*, which is here classed among the bunodonts, is by many placed close to *Hyopotamus*, and *Entelodon* is evidently closely allied in the form of its skull to *Anthracotherium*, though its molars indicate close affinity to the typical bunodonts.

GROUP A: PENTECUSPIDATI.

Upper molars with five columns.

FAMILY 1.—ANTHRACOTHERIDÆ.

General Characters.—This family, as already stated, may be defined as selodont pig-like animals, in which the upper true molars carry five cusps, or columns. These five columns are well displayed in the tooth represented in figure 3 of plate XXIV. The upper molars are divided into a front and hind portion, or 'barrel,' by a transverse cleft (*in the figure the left half of the tooth is the front, and the right, the hind barrel*); the fore 'barrel' carries three, and the hinder, two columns; of these, the columns at the four angles represent the two 'lobes,' and the two 'crescents' of the ruminant molar;¹ while the middle column on the fore barrel represents the anterior wall of the first 'crescent' of the ruminant molar.² In describing these teeth in this memoir, the antero-external column (*left hand top corner of pl. XXIV. fig. 3*) will be termed the 'first outer column'; the postero-internal column (*right hand top corner of figure*) the 'second outer column'; the antero-internal column (*left hand bottom corner of figure*) the 'first inner column'; the postero-internal column (*right hand bottom corner of figure*) the 'second inner column'; while the column wedged in between the first outer and inner columns (*middle of left side of figure*) will be termed the 'accessory, or fifth, column.' Similar terms will be used in describing the lower molars.

As far as is known, the full typical complement of teeth was developed in all members of the family; and in many the canine and premolars attained an excessive development, simulating to some extent those teeth in the carnivora. The skull was elongated, and presented a considerable resemblance to that of the hogs, while the hinder part of the lower jaw in many forms has a resemblance to that of *Merycopotamus* and *Hippopotamus*.

¹ See preceding fasciculus of this volume.

² See Gaudry "Les Enchainements du Monde Animal," pp. 97—8.

In typical members of the family the feet were furnished with four digits, but in some of the earlier species of *Hyopotamus*, like *H. renevieri* and *H. gresslyi* it seems probable that the number of the digits was reduced to two, in which case these forms ought to be referred to a distinct genus. Another well defined didactyle form, of which the teeth are unknown, has been referred to a distinct genus, under the name of *Diplopus aymardi*, and, as already said, probably belongs to a distinct family.

GENUS I: ANTHRACOTHERIUM,¹ Cuvier.

Characters.—With the addition of the new species described in this memoir it is difficult to formulate dental characters which will satisfactorily distinguish this from the next genus. It may, however, be noted that the lowness of the columns, the shallowness of the valleys, the smallness of the outward projections of the angles of the outer surface, and of the loop connecting the outer columns, are characteristic points of the more typical forms. In some forms the whole of the upper premolars are approximated to the true molars, while in others the earlier premolars are separated from the posterior teeth.

Distribution.—As regards distribution in space, remains of this genus have been obtained from Europe and India. In time the genus in Europe, took its origin, according to Professor Albert Gaudry,² in the upper eocene (7th tertiary stage of M. Gaudry), attained its maximum in the lower miocene (9th stage), and disappeared in the middle miocene (11th stage). In India its earliest known occurrence is in the (probably) earlier pliocene, and it may possibly have survived into the higher pliocene.

Number of Species.—The following list contains the names of the best known species, but, as M. Filhol observes, there is a great variation in the size of the molars of many of the so-called species, which would lead to the inference that many of them should rather be regarded as races.

1. ANTHRACOTHERIUM ALSATICUM³ Cuv. Up. eocene and Low. miocene; Europe.
A. alsaticum, Blain.
2. ANTHRACOTHERIUM BREVICEPS,⁴ (Troschel). Low. miocene; Europe.
Sus breviceps, Troschel.
3. ANTHRACOTHERIUM CUVIERI,⁵ Pomel. Miocene; Europe.
A. onoideum, Gervais.
4. ANTHRACOTHERIUM DALMATINUM⁶ Myr. Low. miocene; Europe.
5. ANTHRACOTHERIUM HIPPOIDEUM⁷ Rüt. Low. Miocene; Europe.
6. ANTHRACOTHERIUM HYOPOTAMOIDES⁸ Nobis. Earlier pliocene (?); India.

¹ From *anthrax*, coal, and *therion*, an animal: so named from the occurrence of its remains in the brown coal of the continent.

² "Les Enchaînements du Monde Animal," p. 4. I follow this classification, not using the term "oligocene."

³ Filhol "Phosphorites du Quercy," pl. VIII.—Gervais "Zoologie et Paléontologie Générales," Vol. II., pl. X., fig. 1.

⁴ "Paléontographica," Vol. XXIV., p. 165.

⁵ Blainville "Ostéographie," Anthracotherium, pl. III. (*A. magnum* des Orléanais).

⁶ "Paléontographica," Vol. IV., pl. XI.

⁷ Nov. Mem. Soc. Hal., Vol. XV., pl. I.

⁸ *I'ide infra*.

7. ANTHRACOTHERIUM MAGNUM,¹ (Cuvier). Up. eocene; Europe.*A. avernum*, Kefst.8. ANTHRACOTHERIUM SILISTRENSE,² (Pentland). Earlier pliocene (?); India.

The following species must be abolished, viz :—

A. charoides. Brav.*A. lembronicum*. Brav.*A. minimum* Cuvier=*Hyotherium* or *Charomorus* (teste Gervais).*A. minutum* Cuvier=*Dichodon* or *Amphitragulus*.*A. parisiensis* Blain=*Charopotamus*.*A. sandbergi*?*A. velaunum* Blain=*Hyopotamus*.Species 1. ANTHRACOTHERIUM SILISTRENSE. Pentland, *in parte*.Synonyms. *Anthracotheium punjabiense*, Nobis.*Chæromeryx*, Pomel, *in parte*.*Rhagatherium* (?) *sindiense*, Nobis.

History.—In the year 1829, Mr. Pentland described and figured in the "Transactions of the Geological Society of London,"³ certain mammalian remains obtained by Sir Thomas Colebrooke, from the Siwaliks of Káribári (Caribaree), in the Gáro hills of north-eastern Bengal, in, or adjoining, the district of Sylhet.⁴ These remains comprehended a few specimens of upper molar teeth of small pig-like animals, which were all referred by their original describer to a single species, under the name of *Anthracotheium silistrense*.⁵ In the year 1848, M. Pomel⁶ referred, apparently all, these figured specimens, to a new genus, for which he proposed the name of *Chæromeryx*.⁷ In the "Records of the Geological Survey of India" for 1877,⁸ a five columned upper molar tooth from the lower Manchhars of Sind was described by the present writer, under the name of *Chæromeryx silistrensis*, since it agreed in form with one of the specimens described by Mr. Pentland as *Anthracotheium silistrense*, and subsequently referred by M. Pomel to *Chæromeryx*. In the same paper⁹ a portion of the mandible of a small selenodont pig-like animal, collected by Mr. Theobald in the Siwaliks of the Punjab; was described under the name of *Anthracotheium punjabiense*. At a later date¹⁰ it was shown that Mr. Pentland's original specimens in reality belonged to two distinct genera of selenodont pigs, one of which belonged to the pentacuspidate, and the other to the tetracuspidate group, and that the name *Chæromeryx* should be confined to the latter. It was at the same time considered that the Sind tooth mentioned above, and Mr. Pentland's pentacuspidate specimen, might belong to the genus *Rhagatherium*, and the specific name *sindiense* was proposed for them. In the following year it was shown¹¹ that the two latter teeth really belonged to *Anthracotheium*, and

¹ Blainville, "Ostéographie," *Anthracotheium*.² *Vide infra*.³ Ser. 2, Vol. II., p. 393; pl. 45.⁴ The locality is given by Sir T. Colebrooke, as the left bank of the Brámaputra above Mohendrogranj; but it appears that the river has changed its course since that time.⁵ The Latinised name of Sylhet.⁶ "Comptes Rendus," 1848, p. 687.⁷ From *Chæros*, a pig, and *meros*, a ruminant.⁸ Vol. X., p. 77.⁹ *loc cit*, p. 78.¹⁰ *Ibid*, p. 225.¹¹ "R. G. S. I.," Vol. XI., p. 77.

consequently that Mr. Pentland's original determination of the pentacuspoid upper molar as *Anthracotherium silistrense* was correct, but that the tetracuspoid teeth, forming M. Pomel's genus *Chaeromeryx*, had been included in the same species. It was also shown at the same time that the mandible on the evidence of which the species *A. punjabiense* had been founded, belonged in all probability to the same species as Mr. Pentland's specimen of *Anthracotherium*.

Upper molars.—The type specimen is represented in figures 4 and 5 of plate XLV. of the second volume of the second series of the "Transactions of the Geological Society"; a far better representation of the specimen is, however, given in figures 23 and 23a of plate LXVIII. of the "Fauna Antiqua Sivalensis." The latter figure shows that the tooth is a partially worn upper true molar of the left side, probably the last tooth of the series. The original specimen is stated to have been presented to the Geological Society, but, as it cannot now be found in their collection, the identification of the species must rest upon the figure, which is fortunately amply sufficient. The two teeth represented in figures 10 and 12 of plate XXIII. of the present memoir, were obtained by Messrs. Blanford and Fedden, from the lower Manchhars of Sind, one of them being the specimen referred to in the notice already quoted. These teeth belong to the true molar series of the right side, the specimen represented in figure 10 being partially worn, while the other is an unused germ: the former is probably a third, and the latter a second true molar, and both evidently belong to the same species. If figure 10 be compared with figure 23 of the above quoted plate of the "Fauna Antiqua Sivalensis," and if it be remembered that the teeth belong to opposite sides of the jaw, there will be no question as to the specific identity of the two, whence the Sind teeth are identified with *Anthracotherium silistrense* of Mr. Pentland.

With regard to the correctness of the generic determination of the latter, a comparison of the figures of either of the three Indian teeth with those of typical European species of *Anthracotherium*, such as *A. alsaticum*,¹ or *A. magnum*,² will at once show that the former are correctly referred to the same genus. There does not, however, appear to be any European species with which the Indian teeth can be identified, and, their original reference to a distinct species may, therefore, stand. The European species which approaches nearest in size to the Indian form is *Anthracotherium breviceps* from the lower miocene, or oligocene, brown-coal of Bonn: the figure of the upper molars of this species given by Dr. Böttger³ shows, however, that the inner columns form much more distinctly defined crescents than in the Indian teeth, and there is a more pronounced 'cingulum' in the former. The teeth of *A. alsaticum*, the figures of which have already been referred to, are of larger size than the Indian specimens, but agree very closely in general form, except that in the former there is a more distinct ledge at the bases of the external walls of the

1 H. Filhol, "Recherches sur Les Phosphorites du Quercy," reprint, Paris, 1877, p. 395, fig. 241. Gaudry "Les Enchaînements du Monde Animal, etc.," p. 97, fig. 118.

2 Blainville "Ostéographie," *Anthracotherium*.

3 "Palæontographica," Vol. XXIV., p. 165, fig. 4, a.

151—10 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

outer columns, and, according to the excellent woodcut given by Professor Gaudry, by the greater production of the antero-external angle of the crown. The upper molars of *A. magnum*, to which a reference has likewise been given, are also constructed, as mentioned above, on a very similar type to those of the present species, but are at once distinguished by their much greater size. The molars of *A. cuvieri* are readily distinguished by the more distinct loop, formed by the prominence connecting the external walls of the two outer columns;—a character especially well shown in two molars from Piedmont, in the National Collection at South Kensington. The molars of *Anthracotherium dalnatinum*,¹ if this be indeed distinct from some of the other species, have also a more distinct loop between the outer columns than in the Indian teeth, and are of slightly larger size than the latter. No other species of the genus present any close approximation to the Indian teeth.

It should, however, be observed that the latter present a certain resemblance to the molars of *Chœropotamus parisiensis*, but they are distinguished by the greater tendency to the development of intermediate tubercles in the latter.

The enamel of the Indian teeth is marked superficially by a finely reticulate, or rugose structure. The dimensions of the specimen represented in figure 10 are as follows, viz.: length, 0·68 inch; width, 0·7 inch; height of crown, 0·36 inch.

Mandible.—In figures 1 and 1a of plate XXIV., of this memoir, there is represented the hinder portion of the horizontal moiety of the right ramus of the mandible of an *Anthracotherium*, collected by Mr. Theobald, in the Siwaliks of the Punjab. The fragment shows the three true molars in an early stage of wear; a portion of the associated left ramus of the mandible was also obtained, showing the second and third true molars. The specimen is identical in form with the right ramus of an *Anthracotherium*, previously described by the writer under the name of *A. punjabiense*, and subsequently referred to *A. silistrense*,² but as being the more perfect of the two has been selected for figuring. The molars present the characters of those of typical members of the genus, and do not, therefore, require detailed description. The accessory lobe in the last true molar is well developed, and there is a distinct tubercle at the entrance of the median valley on the external side of each molar. The jaw has its inferior margin strongly convex, and is of considerable relative depth, indicating great power of biting in its owner. Below the hinder extremity of the last molar, the inferior border of the jaw shows a slight in-cutting, probably succeeded in the complete jaw by a descending process, thus recalling the corresponding peculiarity of the lower jaws of *Hypopotamus* and *Merycopotamus*.

It should be observed that in the typical forms of *Anthracotherium* and *Hypopotamus* (such as *A. magnum*, and *H. velatus*), the lower molars of the former are distinguished from those of the latter by their less perfect selenodont form (*compare*

¹ "Palæontographica," Vol. IV., p. 61, pl. XI. This species is referred by Böttger to *Hypopotamus*, but, judging from the figure, seems to be a true *Anthracotherium*.

² *Ide Supra*.

"*Les Enchaînements du Monde Animal*," figs. 111 and 113). In other species, however, as in *A. breviceps*,¹ the molars of *Anthracotherium* are more truly selenodont, and appear to be with great difficulty distinguishable from those of *Hyopotamus*; this appears to be the case with the present and the next species. The dimensions of the specimen are as follows:—

	In.
Length of 1st molar	0·5
Width of " "	0·4
Length of 2nd "	0·6
Width of " "	0·42
Length of 3rd "	0·92
Width of " "	0·44
Depth of jaw	1·38
Thickness of "	0·5

As these dimensions agree so well with those of the upper molars of *Anthracotherium silistrense*, it appears highly probable that the mandible should be referred to that species.

It may be observed that as the premolars are not present it is impossible to say whether the form of those teeth agreed with that of the premolars of *Anthracotherium*, or of the allied genus *Hemihyus*, which appears to be distinguished mainly by the form of these teeth.²

Summary.—No other remains of this species have hitherto come under the writer's notice, but those above described are amply sufficient to prove the former existence, in India, of a small strong-jawed species of anthracothere closely allied to the species from the brown-coal of Europe.

Distribution.—This species had a wide distribution in space, as its upper molars have been found in Sind, in the extreme west of India, and in the Gáro Hills in the extreme east. The lower jaws, on the assumption that they belong to the same species, have been found in the intermediate district of the Punjab. This species, from its occurrence in the lower Manchhar series, is not improbably only of earlier pliocene age, as it is quite probable that the specimens from the Punjab were derived from beds low down in the Siwalik series.

Species 2. ANTHRACOTHERIUM HYOPOTAMOIDES. n. sp. *Nobis*.

History.—This species is mentioned here for the first time, as it is founded on an upper molar tooth obtained in the early part of the year 1882, by Mr. W. T. Blanford, from the lower Manchhar rocks of the Bhúgti hills, north of the Sind frontier, and considered at first to belong to the same species as an upper molar referred to a species of *Hyopotamus*, mentioned in the "Records"³ for that year, and described in the sequel. Other remains described below are provisionally referred to the same species.⁴

¹ "Paléontographica," Vol. XXIV., p. 165, fig. 16.

² See Filhol "Mémoires sur Quelques Mammifères Fossiles des Phosphorites du Quercy," Toulouse, 1882, p. 106.

³ Vol. XV., p. 107. ⁴ Casts of the figured remains of this species, and of *Hyopotamus giganteus* are in the British Museum.

Upper molar.—The specimen of an upper molar referred to above is represented, of the natural size, in figure 2 of plate XXIV.: it is implanted in a fragment of the right maxilla, which also shows the base of the preceding tooth: the perfect tooth is the last true molar. The tooth has unfortunately lost a considerable portion of the first outer column, but is otherwise perfect: it is in an early stage of detrition, the two hinder columns being untouched. The tooth is invested with a highly rugose enamel, a character which, though apparently trivial, will be shown in the sequel to be of some importance. An inspection of the figure will at once show that the tooth belongs to one of the pentacuspitate selenodont Suina, in which the fifth column is well developed. The external surface of the one remaining perfect outer column bears a well developed vertical median ridge, diminishing in width from the base upwards; the lateral borders of the base of the same surface are not produced outwards, so that they do not project beyond the middle point of the base of this surface. The two outer columns are connected by a fold, which in the present condition of the tooth forms an angle, but in a worn condition would form an open loop. The second inner column is rounded externally, and concave internally; it is separated by a shallow valley from the outer column of the same side. The first inner column is irregularly shaped. The transverse median valley of the crown is shallow, and does not become deeper as it passes outwards: there is no 'cingulum.' The dimensions of the specimen are as follows:—

	In.
Length	1.6
Width	1.68
Height of second outer column	0.8

Comparisons.—Comparing the specimen with the upper molars of the genus *Anthracotherium*, we find that in typical species of the latter, as *A. magnum*,¹ *A. alsaticum*² and *A. silistrense* (plate XXIII. fig. 10) the fold connecting the two outer columns is more compressed, and so to speak, more pinched in, and does not form a wide distinct horse-shoe-like loop, but has its outer service flat and bounded by distinct borders, forming a V-shaped shield on the outer surface of the crown. In some species, however, as in *A. curieri*, and especially in the molars of that species from Piedmont in the British Museum already mentioned, there is a better defined loop, but still much less marked than in the present specimen. The shallowness and even depth of the valleys of the latter, and the forms of the columns, as well as the rugose structure of the enamel, are, however, characters of the genus *Anthracotherium*, as distinct from *Hypopotamus*, and the specimen has accordingly been provisionally referred to the former genus. It has, however, characters distinctly approximating it to *Hypopotamus*, to mark which affinity it has been designated *Anthracotherium hypopotamoides*. In size it is intermediate between *A. magnum* and *A. curieri*. It will be shown in the sequel that the resemblance of the tooth is so close to an upper molar from the same locality (pl. XXIV., fig. 3) provisionally

¹ See Blainville "Ostéographie," *Anthracotherium*.

² Filhol. *op. cit.*

referred to *Hypotamus*, that it was at first considered doubtful whether the two could be even specifically separated.

Mandible.—The assignation of their respective lower jaws to allied forms when there are two or more species of nearly the same size is always a matter of extreme difficulty and uncertainty, and in the present instance the reference must be considered purely provisional, or, indeed, merely as a guess. In plate XXV. there are represented three fragments of mandibles of large selenodont Suina, obtained from the Bhūgti hills in company with the foregoing specimen, which must evidently belong either to the present species or to *Hypotamus giganteus*, described in the sequel. These three fragments, although agreeing in the size and structure of their teeth, show such differences in their shape that it is probable that they belong to at least two distinct species, one of which was furnished with a more slender mandible than the other. As it appears that the mandible of *Anthracotherium* is generally of a stouter type than that of *Hypotamus* (compare plate XXIV., figures 1a and 4), the stouter jaw is provisionally assigned to the present species. Of the two specimens showing the last true molar, the specimen represented in figure 1 has the greatest depth of jaw. It shows the hinder part of the last true molar, and a fragment of the horizontal ramus, with the commencement of the surface for the attachment of the masseter muscle. Its dimensions are as follows:—

Depth at second column of molar	In.
Greatest thickness	3.22
Width of last molar	1.5
	1.2

The inferior border exhibits the notch characteristic of *Anthracotherium* and its allies.

In figure 3 of the same plate there is represented a fragment of a right ramus of the mandible showing the second true molar, in an intermediate stage of wear, and a portion of the much-worn first true molar. The dimensions of this specimen are as follows:—

Depth at hinder border of 2nd molar	In.
Length of second molar	3.42
Width of „ „	1.4
	1.16

It will be seen that this specimen is still deeper than the last, but it is possible that the two may have belonged to the two sexes of the same species. No further comparisons can be made with the materials available. The points distinguishing the specimen represented in figure 1 from that in figure 2 will be discussed with the description of the latter, under the head of *Hypotamus giganteus*.

GENUS II. HYOPOTAMUS.¹ Owen. (1847).

- Acodius*. Pomel (1847).
Bothriodon. Aymard (1848).
Cyclognathus. Croiz.
Tapinodon. Meyer.

History and Characters.—This genus was established in 1847, by Professor Owen,² on the evidence of certain molar teeth and jaws obtained by the late Marchioness of

¹ From *hús*, *hús*, a pig, and *potamus*, a river.

² Quar. Jour. Geol. Soc., Vol. iv., p. 143, et seq. D

Hastings from the upper eocene (oligocene) strata of the Hampshire basin. Two species were formed from these specimens, and it was shown at the same time that De Blainville's *Anthracotherium velaunum* must be referred to the new genus. Shortly before the publication of Professor Owen's memoir, the new genus *Ancodus* had been established by M. Pomel,¹ for certain teeth which were subsequently shown to be generically the same as those described as *Hyopotamus*. There is no doubt that M. Pomel's name has the priority, but as Professor Owen's name is almost universally used in England it has been adopted here, although *Ancodus* is largely used by continental palæontologists.² Subsequently other remains were described under the names of *Bothriodon*, *Cyclognathus*, and *Tapinodon*, which were shown by Dr. Kowalevsky³ to belong to *Hyopotamus*. It was also shown by the same writer that certain species referred to *Cainotherium* belonged to the same genus.

In his original description it was at first considered by Professor Owen that *Hyopotamus* differed from *Anthracotherium* by the upper premolars having two 'barrels,' in place of one, but it was subsequently shown that the teeth originally considered as premolars were in reality milk-molars. As was mentioned in the characters of the family, the whole number of the typical placental dentition is always present, but there is considerable diversity as to the position of the anterior premolars, and the relative size of the canines. Thus in *H. leptorhynchus* the first premolar is separated by a long interval from the other three teeth of that series, which are all in apposition, and the canine is large. In the form known as *H. aymardi*, which is very probably the female of the last, the first and second premolars are separated by 'diastemæ' of equal lengths from the third and fourth premolars, and the canine is small. In *H. velaunus* the first premolar only is separated from the others by a small 'diastema,' and the canine is small. The skull, in those forms in which it is known, is remarkable for the elongation of the facial portion, for the smallness of the brain cavity, and for the absence of a 'larmier,' (Filhol.) The upper true molars of the typical forms are distinguished from those of typical forms of *Anthracotherium* by the more distinct and wider loop formed on the outer border of the masticating surface at the union of the two outer columns. (*This difference is admirably shown in figures 6 and 9 of plate VII. of Professor Owen's memoir, where the molars of Anthracotherium magnum (fig. 9) are reduced to the same size as those of Hyopotamus vectianus (fig. 6).)* There is, however, such a gradual transition, through less typical forms, from *Hyopotamus* to *Anthracotherium* in these respects, that it is almost impossible to give definite generic characters founded on the structure of the molar teeth, and it is not impossible, as previously observed, that the two genera may eventually have to be amalgamated.

Distribution.—The genus *Hyopotamus* has a very extensive distribution in space, its remains having been obtained from the tertiaries of India, Europe, and North

¹ 'Archives de la Bibliothèque de Genève,' Vol. VII., 1847.

² Dr. Kowalevsky ('Phil. Trans.' loc. cit., p. 22.) attempted to show that *Ancodus* was never defined, but Dr. Filhol

('Mammifères de Ronzon,' p. 87.) has shown that this is erroneous.

³ 'Phil. Trans.,' loc. cit.

America. Its range in time is from the upper eocene (5th tertiary stage of Gaudry) to the lower miocene in Europe, while in India it survived (probably) to the earlier pliocene. Its maximum of development in Europe occurred in the lower miocene (8th tertiary stage.) In America it seems to be confined to the miocene.

Number of species.—There is very great difficulty in arriving at a satisfactory conclusion as to the number of species of the genus, owing to the numerous synonyms, and the confusion caused by writers wrongly identifying new forms with previously described species. Dr. H. Filhol, in his memoir on the fossil mammals of Ronzon,¹ has endeavoured to correct the synonymy of the French and English species, and comes to the conclusion that they should all be referred to four species, which he respectively terms—(1) *Ancodus velaunus* Pomel, (2) *A. leptorhynchus* Pomel, (3) *A. bovinus* Owen, and (4) *A. porcinus* Gervais. In the first species he includes the English *Hyopotamus vectianus* of Professor Owen, and in the second *Ancodus aymardi* of M. Pomel, the skull of which is figured under the latter name on plate XVI of his memoir, but which on page 188 of the same is shown to belong probably to a female of *A. leptorhynchus*. Thus far Dr. Filhol is clear enough, but on page 99 he observes “that the *Ancodus velaunus* of M. Pomel does not correspond to *Bothriodon velaunus* of M. Aymard, as one might at first suppose, but to *Bothriodon platyrhynchus* of the same author; and that the *Ancodus aymardi* of M. Pomel is the *Bothriodon velaunus* of M. Aymard.” This may shortly be expressed as follows, viz.:—

A. velaunus. Pom.=*B. platyrhynchus*. Aym.

And *B. velaunus*. Aym.=*A. aymardi* Pomel.

On page 186, it is stated that “the animals described under the names *Ancodus incertus* Pomel, *Hyopotamus borbonicus* Gervais, *Ancodus aymardi* Pomel, and *Bothriodon velaunus* Aymard form one and the same species.” On page 189 *H. borbonicus* is classed as a synonym of *A. velaunus* Pomel, and as it was before considered to be the same as *A. aymardi* Pomel, it follows that *A. aymardi* Pomel is the same as *A. velaunus* Pomel, and consequently that the latter is the same as *Bothriodon velaunus* of M. Aymard, which we were expressly told at first was not the case. In respect of these species M. Filhol has, indeed, made the ‘confusion worse confounded,’ and without the whole series of type specimens for comparison it is quite impossible to give a correct list of the synonymy and number of the species.

The following list must, therefore, only be considered as an approximation to the truth; the hypothetical reference of the form known as *Hyopotamus aymardi* to *H. leptorhynchus* is indicated by a note of interrogation; and also that of *H. vectianus* of Owen to *H. velaunus*. The European species additional to the four French and English species admitted by M. Filhol are given on the authority of Dr. Kowalevsky. *H. borbonicus* is identified with *H. vectianus*, whether or not the latter species is the same as *H. velaunus*.

¹ *loc. cit.* reprint, p. 189.

157—16 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

1. HYOPOTAMUS AMERICANUS,¹ Leidy. Miocene; N. America.
2. HYOPOTAMUS BOVINUS,² Owen. Up. eocene (5th stage); Europe.
3. HYOPOTAMUS CRISPUS,³ Gervais. Low. miocene; Europe.
- *4. HYOPOTAMUS GERGOVIANUS,⁴ (Croiz). Low. miocene; Europe.
Anthracotherium gergovianum. Croiz.
Cyclognathus gergovianus. Croiz.
5. HYOPOTAMUS GIGANTEUS,⁵ *Nobis*. Earlier pliocene (?); India.
6. HYOPOTAMUS GRESLYI,⁶ Rüt. Up. eocene; Europe.
Tapinodon greslyi. Myr.
7. HYOPOTAMUS LEPTORHYNCHUS,⁷ (Pomel). Low. miocene; Europe.
(?) Ancodus aymardi. Pomel.
Ancodus insignis. Filhol.
Ancodus leptorhynchus. Pomel.
Ancodus macrorhinus. Pomel.
Bothriodon insignis. Filhol.
Bothriodon leptorhynchus. Aymard.
Bothriodon velaunus. Aymard.
8. HYOPOTAMUS PALÆINDICUS,⁸ *Nobis*. Earlier pliocene (?); India.
9. HYOPOTAMUS PORCINUS,⁹ Gervais. Low. miocene; Europe.
10. HYOPOTAMUS RENEVIERI,¹⁰ (Pictet). Up. eocene (?); Europe.
Cainotherium renevieri. Pictet.
Cainotherium courtisii. Pictet.
11. HYOPOTAMUS VELAUNUS,¹¹ (Blain). Up. eocene, and low. miocene (8th stage); Europe.
(?) Ancodus borbonicus. Gervais.
Ancodus incertus. Pomel.
Ancodus velaunus. Pomel.
Anthracotherium velaunum. Blain.
Bothriodon platyrhynchus. Aymard.
(?) Hyopotamus borbonicus. Gervais.
(?) Hyopotamus velaunus.¹² Owen.

Hyopotamus guyotanus, Cope, belongs to *Merycopater*.

¹ Jour. Acad. Nat. Sci. Philad., Ser. 2, Vol. VII., pl. XXI., fig. 1. ² Quar. Jour. Geol. Soc., Vol. IV., pl. VII., fig. 1.
³ Pictet, "Paléontologie Suisse," Vol. V., pl. XXIV., figs. 8-13. ⁴ Blainville "Ostéographie," Anthracotherium, pl. III.
⁵ *Vide infra*. ⁶ Pictet "Paléontologie Suisse," Vol. V., pl. XXIV., figs. 4-7. ⁷ Nov. Mem. Soc. Hel. Vol. XIX., pl. V., figs. 64-7. ⁸ Filhol. "Mammifères de Ronzon," pls. XV. XVI., (*d. aymardi*). ⁹ *Vide infra*.
¹⁰ Gervais "Zool. et. Paléontologie Françaises," pl. XXXI., fig. 8. ¹¹ Filhol "Mammifères de Ronzon," pl. XVIII.
¹² This species is introduced as a synonym of *H. velatus* solely on the authority of Dr. Filhol (*loc. cit.*), but in the sequel is frequently treated as a distinct species: if really distinct *H. borbonicus* should be referred to it, and perhaps some of the other synonyms. (See Gervais, *loc. cit.*, p. 192.)

Species 1.—*HYOPOTAMUS PALÆINDICUS*. n. sp. *Nobis*.

History.—This species was first named by the writer in the year 1877¹ on the evidence of two small upper molar teeth, obtained by Mr. W. T. Blanford in the lower Manchhar rocks of Sind. Other teeth, together with a portion of the mandible, were subsequently obtained from the same strata by Messrs. Blanford and Fedden, and have also been briefly noticed in the "Records."² All the above specimens form the subject of the present fuller notice.

Upper molars.—In figures 4 and 6 of plate XXIII. of this memoir there are represented, from the masticating aspect, the two most perfect specimens of the above-mentioned upper true molars. The specimen represented in figure 4 belongs to the right side, has been but little abraded by wear, and is most probably the last true molar. The specimen represented in figure 6 is from the opposite side, has been considerably more worn down, and is probably the second true molar: both specimens are quite perfect. The external aspect of the specimen represented in figure 4 is given in figure 7. These teeth present all the essential characters of the upper molars of the genus *Hyopotamus*; the fifth, or accessory column, is of relatively small size, but can be distinguished, in its unworn condition, on the right side of figure 4, but in figure 6 it has become confluent by wear with the antero-internal column (*left side of figure*). The crown is remarkably low, surrounded on three sides by a well defined 'cingulum,' and invested with a striated enamel. Although, as has been already mentioned, these teeth present a strong resemblance in their general plan of structure to those of the European and American species of *Hyopotamus*, yet when examined in more detail they present such differences as to leave no doubt of the specific distinctness of the form to which they belonged, though it is much to be desired that materials may eventually be forthcoming which will enable more full comparisons to be made. The most important points of distinction of the Indian teeth are the much more prominent development of the vertical ridges on the external surfaces of the outer columns, and also the smaller relative size of the fifth column. The following comparisons indicate these differences in the species approaching in size to the Indian teeth. In all the three skulls figured by M. Filhol, in his memoir on the fossil mammals of Ronzon quoted above,³ under the names of *Hyopotamus* (*Ancodus*) *leptorhynchus*, *H. aymardi*, and *H. velauvus*, the fifth column is very much more developed than in the Indian teeth, being frequently as large as the other columns, while, as far as can be judged from the figures, the median vertical ridges on the external surfaces of the outer lobes, so conspicuous in the Indian teeth, appear to be wanting. In the molars of the large *H. bovinus*⁴ from the Isle of Wight these ridges are likewise wanting. In the molars in the British Museum belonging to the form described by Professor Owen under the name of *H. vectianus*,⁵ but identified by

¹ 'R. G. S. I.', Vol. X., p. 77.² Vol. XI., p. 80.³ Pls. XV. to XVII. An excellent woodcut of an upper molar of *H. velauvus* is given by M. Gaudry, *loc. cit.*, p. 98, fig. 122.⁴ Owen *loc. cit.*, pl. VII., fig. 1.⁵ *Ibid*, pl. VII., fig. 6.

M. Filhol with *H. velaunus*, there is a distinct ridge present on each column, but, as in the other European forms, the external angles of each of the outer columns, are much more developed than in the Indian teeth, and project outwardly beyond the plane of the median ridges, in much the same manner as in the molar represented in figure 5 of plate XXIII. of the present memoir. The presence of these ridges in the Isle of Wight teeth, and their apparent absence in those of the continental *H. velaunus* would seem to throw some doubt on M. Filhol's identification of the two forms. In the sequel *H. vectianus* is still provisionally classed as a distinct species, if only for the sake of convenience of reference. In *H. americanus*¹ (distinguished by its taller columns, and larger fifth column), and in the small *H. gresslyi*,² the median ridge is more developed than in any other non-Indian form, but still much less so than in the Indian teeth. The other European forms are of smaller size, and do not approach closely to the Indian teeth.

On the whole it would seem that there is little, if any doubt, but that the Indian teeth should be referred to the genus *Hyopotamus*, but that they belong to a slightly abnormal division of it. This reference will be found to be of considerable importance with regard to the generic determination of the teeth of the next species. The dimensions of the specimen represented in figure 4 are as follows:—*viz.*, length, 0·8 inch; breadth, 0·89 inch; height of crown, 0·45 inch. The specimen represented in figure 6 is of slightly larger dimensions.

Lower molar.—In figure 3 of plate XXIII, there is represented the greater portion of the third left lower molar of a hyopotamid, obtained by Mr. W. T. Blanford in Sind. The tooth has lost its third, or last barrel, but is otherwise perfect, and is in an intermediate condition of wear: it agrees in all general respects with the lower molars of *Hyopotamus*, and is of about the same size as the last lower molar of the European *H. bovinus*. The crown is, however, lower than in most European forms, in which respect it corresponds with the upper teeth. The size of the tooth renders it rather large to have belonged to the same species as the upper molars described above, which are nearly equal in size to those of *H. vectianus*, but since we have seen that there is some variation in the size of the upper teeth, and as it is extremely undesirable to form new species on such scanty evidence, and without a fair amount of certainty, it seems better to provisionally refer the lower tooth to the same species as the upper. It may be added that the tooth is readily distinguished from the lower molar of *Merycopotamus* by the greater stoutness and breadth of the barrels, by the more rounded contour of the inner columns, and by the smaller degree of elevation and sharpness of the whole crown, and especially of its outer columns.

Mandible.—In figure 4 of plate XXIV. there is represented, from the external aspect, the portion of the left ramus of the mandible noticed in the passage in the

¹ Leidy, "Jour. Acad. Nat. Sci. Philad.," Vol. VII., pl. XXI., fig. 1. An excellent woodcut of an upper molar is given by Professor Cope "Origin of Types of Molar Teeth, etc.," Philadelphia, 1874, p. II., fig. 8. The comparisons given in the text are chiefly made from a cast of the molars in the British Museum.

² Pictet, "Paléontologie Suisse," Vol. V., pl. XXIV., figs. 12 and 13.

"Records" already quoted, and provisionally referred to *Hyopotamus palawindicus*: the specimen was obtained by Mr. Fedden, from the lower Manchhars of Sind. It comprises the posterior part of the horizontal ramus, showing the bases of the second and third true molars, and the anterior part of the surface for the attachment of the masseter muscle. The jaw is slender and elongated, the inferior border of the dentigerous portion being nearly straight and inclining rapidly upwards: posteriorly to this portion there is a broad open notch, and then the commencement of a descending process. Both the notch and the descending process are much less developed than in *Merycopotamus*, in which genus the mandible is relatively much stouter and deeper. The form of the section of the last true molar agrees precisely with the base of the last lower molar represented in figure 3 of plate XXIII., and provisionally referred to *Hyopotamus palawindicus*, and it, therefore, seems almost certain that the two specimens belong to the same species. The figured jaw agrees very closely with the corresponding portion of the mandible of *Hyopotamus bovinus* figured by Professor Owen, in the memoir already quoted;¹ but its resemblance to the slender jaw of the so-called *H. aymardi*,² in which the descending plate at the angle is largely developed, is still more close. The depth of the Sind jaw is 1·3 inches, and the length of the last true molar 1·36 inches. It will thus be seen that the present jaw is of a more slender type than that of the small *Anthracotherium silistrense* described above; in this point, therefore, the two Indian specimens respectively agree with the proportionate forms of the jaws of the European species of *Hyopotamus* and *Anthracotherium*.

Distribution.—Remains of this species have hitherto been obtained only from the lower Manchhar rocks of Sind.

Species 2. *HYOPOTAMUS GIGANTEUS*. n. sp. *Nobis*.

History.—As there seem to be two species of Indian *Anthracotherium*, the one large and the other small, so there appears to have been a large and a small species of *Hyopotamus*, the former forming the subject of the present notice. The only previous notice of this species is a statement in the "Records" for 1882,³ to the effect that Mr. W. T. Blanford had in the early part of that year obtained from the lower Manchhar rocks of the Bhúgti hills, to the north of the Sind frontier, several molars of a species of *Hyopotamus* of larger size than those of any known species of the genus. Among these teeth was, however, included the above-described upper molar on which *Anthracotherium hyopotamoides* is founded, and there consequently only remain two teeth which can certainly be ascribed to the present species.

Upper molar.—In figure 3 of plate XXIV. there is figured one of the two molar teeth discovered by Mr. Blanford. The specimen is a last upper molar, as is gathered from the absence of a disc of pressure on the posterior aspect of the crown, and is in a middle condition of wear: it has lost its two outer angles, and a portion of the loop connecting the two outer columns, but is otherwise perfect.

¹ 'Quar. Jour. Geol. Soc.,' Vol. IV., pl. VIII., fig. 3.

² "Mammifères Fossiles de Ronzon," pl. XXI.

³ Vol. XV., p. 107.

It will be observed from a comparison of the two figures (plate XXIV. figures 2 and 3) that this tooth is of precisely the same dimensions as the corresponding tooth, of the opposite side of the jaw, of *Anthracotherium hyopotamoides*; and the general resemblance between the two is indeed so close, that, as has already been said, they were on a first examination referred to the same species. A closer examination has, however, shown that not only must they in all probability be referred to distinct species, but according to the present classification to distinct genera, though they afford the strongest grounds for the ultimate fusion of these two genera.

It will be simplest to indicate in the first place how the tooth before us differs from the upper molar of *Anthracotherium hyopotamoides*; and it must be observed that this comparison is rendered somewhat difficult by the different states of wear of the two specimens. The tooth under consideration is firstly distinguished from the latter by the structure of the enamel, which is marked by longitudinal striæ, in place of being rugose.¹ It is also distinguished by the presence of a very marked 'cingulum,' encircling the inner half of the base of the crown. Further, the median transverse valley, in place of being of the same depth throughout its course, becomes much deeper in the middle, and at its outer extremity. Perhaps, however, the most important differences occur on the external surfaces of the two teeth; differences unfortunately to a great extent obscured by the fracture of the external angles of the specimen under consideration. Those angles, however, when perfect must evidently have been greatly produced outwards, and have curved over the flat portions of the external surfaces of the two outer columns in much the same manner as in typical species of *Hyopotamus*.² Again, these surfaces are less nearly vertical, sloping more towards the inner side than in *A. hyopotamoides*, and the centres of their bases are depressed below their lateral borders, while all are in one plane in the latter.



Fig. 1. *Hyopotamus giganteus*; 3rd left upper true molar.—Bhûgti hills.

The second specimen, which is represented in the accompanying woodcut, is also a third left upper molar, as is proved by the absence of a pressure disc on the posterior side, and is slightly larger than the first specimen. It was also obtained in the Bhûgti hills, and is in an early stage of wear. A part of the anterior side has been broken away, and also the enamel of the external surface of the first outer column. A comparison of this specimen with the upper molar of *Anthracotherium hyopotamoides* will at once show the striking differences between the external surfaces of the outer columns of the two specimens, and the greater production of the connecting loop in the tooth under consideration. In the second outer column of

¹ The difference in the structure of the enamel in these two specimens is not shown in the figure, but is well exhibited in the excellent casts in the British Museum.

² See Owen 'Quar. Jour. Geol. Soc.,' Vol. IV., p. VII.

the tooth of *A. hyopotamoides* (*left side of figure*) the middle vertical ridge is very large and wide, and is so largely developed that if a rod be laid on the external surface of this column, it will rest on this median ridge, as well as on the lateral borders of the surface. In the corresponding part of the tooth under consideration (*right side of woodcut*), the median ridge is greatly depressed below the plane of the lateral borders of the external surface of the column: this depression is so extensive that a rod placed as before will be raised more than a third of an inch above the median ridge. The central part of the external surface of the first column is similarly depressed in this tooth, and elevated in the tooth of *A. hyopotamoides*, but the damaged condition of this part in all the three specimens forbids a closer comparison. The tooth figured in the woodcut agrees in all respects with the specimen represented in plate XXIV, figure 3, except that the 'cingulum' in the former is rather less fully developed than in the latter.

The foregoing comparisons lead to the conclusion, improbable as it at first sight appears, that the two molars last described, although agreeing in size, are so different from the molar of *Anthracotherium hyopotamoides* that it seems difficult to refer them to the same species. A comparison of these two teeth with the tooth represented in plate XXIII, figure 4, will, moreover, lead to the conclusion that the three teeth belong to the same genus of animal, and as it was shown that the specimen above-mentioned could not be separated from the genus *Hyopotamus*, it will be necessary to refer, provisionally, the two larger teeth to the same genus. As no named species has teeth as large as these specimens, if the generic determination be correct, it is clear that these specimens must belong to a new species, for which the name of *H. giganteus* is proposed.

The close similarity existing between the upper molars of *Hyopotamus giganteus* and those of *Anthracotherium hyopotamoides*, and the gradual transition in respect of the character of the teeth thus effected between the two genera, seems to render it highly probable that there may be a similar transition in respect of the cranial characters, and that eventually the two genera will have to be fused together, though it has not been considered advisable to adopt this course on the evidence of the present inadequate materials. Should this course be eventually considered advisable the older name *Anthracotherium* must stand for the extended genus, and the family name *Anthracotheriidae* entirely replace the name *Hyopotamidae*, the latter course having been adopted in the present memoir. The transition from the typical form of one genus to that of the other is exhibited in the following list, which, however, does include all the species.

Anthracotherium magnum (type)	
————	alsaticum.
————	sillistrense.
————	cuvieri.
————	hyopotamoides.

Hypotamius	giganteus.
————	palaeindicus.
————	americanus.
————	gresslyi.
————	(?) vectianus.
————	velaunus.
————	bovinus (type). ¹

Mandible.—The three fragmentary specimens of mandibles of hypotamids from the Bhūgti hills, represented in plate XXV. of this memoir, have been already partially discussed under the head of *Anthracotherium hypotamoides*; the specimen represented in figure 1 being provisionally referred to that species, and that in figure 3 being considered to possibly belong to the same. The specimen represented in figure 2, comprising the same portion as that represented in figure 1, but differing from it in form, is provisionally referred to the present species, and its distinction from the mandible assigned to *Anthracotherium hypotamoides* will now be pointed out.² The specimen represented in figure 2 comprehends the hinder portion of the right ramus of the mandible, perfect for the length of the last true molar, but in front only showing the lower half of the ramus for a length of some three inches, and posteriorly the anterior part of the surface for the attachment of the masseter muscle. The specimen shows the half-worn last true molar, which is perfect, with the exception of a portion of the enamel of the third barrel.

The tooth in this jaw cannot be distinguished by any satisfactory characters from that of the jaw represented in figure 1, but the differences in the jaws themselves are considerable, and will now be pointed out. In figure 1 the whole jaw is deeper, the notch on the inferior border more distinctly marked, while the diminution in depth anteriorly, as far as can be judged from the portion remaining, is less rapid than in figure 2. Again, in figure 1 the prominence for muscular attachment on the anterior border of the masseteric fossa (*seen in the middle of the curved line to the left of the figure*), is placed much nearer to the molar than in figure 1 (*seen on the left side of the inferior border of the figure*). On the superior aspect the portion below the hinder part of the molar, on the outer side, forms a more distinctly separate surface in figure 1 than in figure 2: while on the external surface, the specimen represented in figure 1 is much more curved than the other. Some of the above differences are indicated more clearly by the following table of measurements.

	Fig. 1.	Fig. 2.
Depth at second column of molar	3·22	3·05
„ „ first „ „ „		2·9
Interval between prominence on anterior border of masseteric fossa & molar	2·24	1·7
Greatest thickness	1·5	1·56
Length of molar		2·08
Width „ „	1·2	1·19

¹ It may be mentioned that a species has been described under the name of *Hypotamius helveticus*, Rüf., from the miocene of Switzerland, which is probably the same as one of the species given in the previous list.

² When these specimens were figured it was considered that they belonged to the same species: if the present view as to their distinctness had been then entertained, the specimen represented in figure 1 would have been viewed from the same aspect as that in figure 2. The reader who is desirous of verifying the differences pointed out here, can do so by comparing the casts of the specimens in the British Museum.

Owing to the imperfect condition of the specimens, further comparisons are impracticable, but the differences pointed out confirm the inferences drawn from the upper molars as to the former existence of two species of large hyopotamids in the Bhúgti hills. It is very remarkable that in one small spot (for all the remains of these forms were collected by Mr. Blanford in one day), remains of two such highly interesting, and previously totally unknown forms, should have been obtained, and it points to the great promise of these districts as a future field of research. Since, however, the Bhúgti hills are beyond the British frontier, among unruly tribes, it requires special arrangements by Government to enable any European visitor to travel through them, and it is hence unlikely that any scientific person will again visit them for a long period. The locality whence most of Mr. Blanford's specimens were obtained is known by the name of Gándri.

GROUP B: TETRACUSPIDATI.

Upper molars with only four columns.

FAMILY 2.—MERYCOPOTAMIDÆ.

Characters.—This family may be defined as selenodont Suina in which the upper molars have only four columns, while the mandible, as far as is known, is furnished with a large descending plate, or process, at the angle; the latter character distinguishing it from the *Oreodontidæ*.

GENUS I: MERYCOPOTAMUS,¹ Falconer and Cautley.

As this and most of the succeeding genera are each represented by only a single species, the generic characters are the same as those of the species.²

Species. MERYCOPOTAMUS DISSIMILIS. Falconer and Cautley.

Synonyms. *Hippopotamus dissimilis*. F. and C.

Merycopotamus sivalensis. F. and C.

History.—In the year 1839, Messrs. Falconer and Cautley³ described the remains of a pig-like animal from the sub-Himalayan Siwaliks, under the name of *Hippopotamus dissimilis*. Subsequently it was found that the teeth differed so essentially from those of the hippopotamus that a new genus—*Merycopotamus*—was created for the reception of this form. A fine series of the remains are figured under the latter name in the "Fauna Antiqua Sivalensis,"⁴ most of which are now in the British Museum. There is also a fine series in the Indian Museum. A notice of the osteology of this remarkable form was published by the present writer in the

¹ From *meris*, a ruminant, and *potamos* a river.

² A second species of *Merycopotamus* is mentioned by Dr. Falconer, but cannot be identified.

³ "Paleontological Memoirs," Vol. I., pp. 130-138, *et. seq.*

⁴ Plates LXII., LVII., and LVIII.

"Records of the Geological Survey of India" for 1876,¹ and a supplement to the same was published in the following year.² All the more important notices of this species previously published are recorded in those papers, and as no additional remains are described in the present memoir only a summary of its more important characters will be given.

Characters.—As far as can be determined from the remains known to us, *Merycopotamus dissimilis* was probably either a pente—or tetradactylate pig-like animal of about the size of the wild boar. Its dentition comprises, as far as is known, the complete placental mammalian series. The canines are relatively large, approximated to the incisors, but separated by a long 'diastema' from the premolars. The anterior premolars are sharply pointed like those of *Anthracotherium* and *Hippopotamus*: the anterior premolar is placed close to the succeeding tooth, a character in which *Merycopotamus* agrees with the pig, and differs from the hippopotamus. The upper true molars, of which there is an excellent figure in plate LXII. figure 17 of the "Fauna Antiqua Sivalensis,"³ are selenodont teeth with four distinct columns, and with a well-marked 'cingulum' on their inner halves: their enamel is coarsely rugose. The external surfaces of the outer columns slope towards the centre of the crown, and their basal angles are folded over their centres, which thus become concave: a well-marked ridge occupies the median line of each of these surfaces: the loop connecting these surfaces does not project on the external surface of the crown. The crowns are remarkably low, and a rudely cruciform valley, open to the bottom, separates the four columns;—characters by which the teeth are readily distinguished from those of the true ruminants. With the exception of the absence of the fifth lobe, and the smaller development of the loop connecting the outer columns, the teeth present a striking resemblance to those of *Hypopotamus paleoindicus*; the basal angles of the external surfaces of the outer columns are, however, more produced in the former. The lower molars are of the general type of those of the selenodont Suina.

The cranium presents a considerable resemblance to that of the hippopotamus, which is, perhaps most marked in the occipital region (compare "*F. A. S.*," plate LX. fig. 4c, and plate LXVIII., fig. 15): the parietal region is, however, longer and more compressed, the orbits less prominent, and the infraorbital portion longer and less expanded at its extremity. In all the points in which the skull of *Merycopotamus* differs from that of the hippopotamus, it agrees with the skulls of the *Anthracotheridae* and the true pigs. The skull is shorter than the skulls of those species of *Hypopotamus* of which the skull is known, and also differs by the presence of a distinct alar cavity. The most striking affinity to the hippopotamus is displayed by the form of

¹ Vol. IX., p. 144, et. seq., on page 153, line 12 from the bottom, the words *Hippopotamidae* and *Anthracotheridae* should be transposed.

² *Ibid* Vol. X., p. 34.

³ A woodcut of a single molar is given in Professor Owen's memoir on *Hypopotamus*, cited above; another figure in the "Odontography" of the same author, (pl. CXL., fig. 8); and a third by Professor Gaudry. ("Les Enchaînements du Monde Animal, etc.," p. 98, fig. 124.)

the mandible (*compare* "F. A. S.," plate LXI., fig. 6a, and plate LXVII., fig. 4), as in both genera the 'angle' is produced into a large descending plate, preceded by a deep notch in the inferior border of the horizontal ramus: this plate and notch are, however, developed to a smaller extent in the *Anthracotheridae* (plate XXIV. figure 4).

The limb-bones are nearer those of the *Anthracotheridae* than those of the hippopotamus, as is well exemplified by the more elongated form of the astragalus (*compare* "F. A. S.," plate LXVIII., figures 9 and 20); and by the separation of the radius and ulna, and their much more elongated form. The axis vertebra, of which there is a specimen in the Indian Museum, is an elongated bone like that of *Hyopotamus*.

Position of the genus.—After their assignation of *Merycopotamus* to the rank of a distinct genus, the authors of the "Fauna Antiqua Sivalensis" still referred it to the family *Hippopotamidae*, a reference which has been upheld by several later writers.¹ The intimate resemblance of the molars to those of the *Anthracotheridae* and *Oreodontidae* leaves, however, little doubt but that the true position of the genus is in immediate juxtaposition to those families: the form of the mandible indicates, on the other hand, a distant cousinship with the hippopotamus.

Distribution.—Remains of this species have hitherto been obtained only from the Siwaliks of Burma and the sub-Himalaya; the statements of their alleged occurrence in the Manchhars of Sind having been founded on bones belonging probably to allied genera.

GENUS II: CHÆROMERYX,² Pomel.

Species: CHÆROMERYX SILISTRENSIS. (Pentland), *in parte*.

Synonym. *Anthracotherium silistrense*. Pentland, *in parte*.

History and general characters.—This genus and species is only known by the one fragment of a maxilla with three molars, obtained from the Gáro hills, and described by Mr. Pentland, in the memoir quoted above, together with other remains, under the name of *Anthracotherium silistrense*. As already stated in the notice of that species, all these remains were referred, in 1848, by M. Pomel to a new genus under the name of *Chæromeryx*, while it was subsequently shown by the present writer that this title should be confined to the one maxilla in which the molars are four-columned selenodont teeth. It has not been found possible to discover where this maxilla now is, but as a fair figure of it is given in Mr. Pentland's memoir,³ and an excellent one in the "Fauna Antiqua Sivalensis," (plate LXVIII., figures 22 and 22a), there is no difficulty in determining its affinities. There is a cast of the specimen in the Indian Museum.

Upper molars.—The above mentioned maxilla, as is shown by the figures, contains three teeth, and belongs to the left side of the skull. The teeth are but slightly abraded by wear, and are, respectively, the last premolar (*left side of figure*)

¹ See Huxley, "Anatomy of Vertebrated Animals," 1st ed., p. 375.

² From *choiros*, a pig, and *mérie*.

³ "Trans. Geol. Soc.," Ser. 2., Vol. II., pl., XLV., figs. 2 and 3.

and the first and second true molars: the first true molar is considerably smaller than the second: the largest tooth is about half-an-inch in length, and four-and-a-half tenths in width. Each of the true molars carries four distinct columns, the summits of the inner pair forming complete crescents: there is a wide 'cingulum' on the inner side. The external walls of the outer columns are more nearly perpendicular than in *Merycopotamus*, the angles of their bases less produced and the median ridges less developed. There is a more distinct loop connecting the external surfaces of these columns; but this is flattened externally, and overlaps each column.

There can be little, if any, doubt but that these teeth are generically distinct from *Merycopotamus*, though they probably belong to the same family.

These teeth also present considerable resemblance to a tooth figured by Dr. W. Kowalevsky as belonging to a form intermediate between *Hyopotamus* and *Dichodon*.¹ The latter tooth which has four lobes and a prominent connecting loop, has, however, a more truly ruminant structure, which is still more developed in *Dichodon*² itself.

GENUS III: HEMIMERYX,³ n. gen. *nobis*.

Species: HEMIMERYX BLANFORDI. n. sp.: *nobis*.

History.—Unsatisfactory as it is to form a new genus of animals merely on the evidence of a single tooth, still there are certain cases where there seems no satisfactory alternative but to adopt this proceeding; and the present and following instances are cases in point. In both of these instances a single upper molar is before us, which cannot at present be identified with the molars of any described genus, and we have accordingly either to give these teeth new generic names, or to suffer the inconvenience of here and elsewhere alluding to them, without any distinctive title or means of identification. Under these circumstances the former alternative, as being the least objectionable of the two, has been adopted.

In the "Records" for 1877,⁴ an upper molar tooth obtained by Mr. W. T. Blanford from the lower Manchhars of Sind was briefly noticed, and considered to belong to a new genus of merycopotamid. In the following year⁵ two other fragments of similar upper molars, and a lower molar considered as probably belonging to the same species (all obtained from the lower Manchhar rocks) were also noticed, and the generic term *Hemimeryx* was proposed for their reception. The best of the above mentioned specimens are now for the first time figured, and are designated by the foregoing generic title, with the specific name of *blanfordi*, after the discoverer of the first specimen.

Upper molar.—In figures 5 and 8, of plate XXIII. of this memoir, the original upper molar noticed above is represented. Figure 5 gives a view of the masticating surface, while in figure 8 the external aspect has been portrayed, but it unfortunately

¹ 'Phil. Trans.' *loc. cit.*, pl. XXXIX., fig. 15.

² Owen, *loc. cit.*, pl. IV., fig. 3.

³ From *Hemi*, half, and *méryx*.

⁴ Vol. X., p. 78.

⁵ "R. G. S. I.," Vol. XI., pp. 79-80.

happens that the specimen has been turned upside down, so that to see the tooth in its natural position the plate must likewise be reversed. The specimen is complete with the exception of the extremities of the 'fangs,' and is a true molar (possibly the last) belonging to the left side: the tips of the columns are but slightly abraded by wear. The crown carries four crescentoid columns on the masticating surface, relatively higher than those of *Merycopotamus*. The general form of these columns is much the same in the two genera, with the important exceptions that in the postero-external column (*right upper angle of figure*) the outer surface is simply concave without any median ridge, while the corresponding surface of the antero-external column (*left upper angle of figure*) has the median ridge, though present, much more faintly developed than in *Merycopotamus*. The loop between the two external columns is much more developed than in that genus, projecting beyond the outer border of the crown. The antero-internal column (*left lower angle of figure*) is greatly developed at its anterior, and incompletely at its posterior side. As in *Merycopotamus* there is a distinct 'cingulum' on three sides of the base of the crown. The size of the tooth is about the same as that of large individuals of the latter genus; its dimensions are as follows: *viz.*—length, 1.13 inches; breadth, 1.1 inches; height, 0.81 inch.

The tooth is distinguished from the molars of *Chaeromeryx* by the oblique direction of the external surfaces of the outer columns, by the incompleteness of the 'crescents' of the inner columns, and by the form of the loop connecting the outer columns. The resemblance between the tooth and the molars of *Merycopotamus* and *Chaeromeryx* is, however, sufficiently strong to render it probable that it belongs to the same family. It does not appear to come as near to the molars of any other genus as to those of *Chaeromeryx* and *Merycopotamus*, from which, however, it is most markedly distinct. In the points in which it differs from the latter genus it approximates to the molars of the *Anoplotheridae* and the true ruminants. It has, indeed, a very marked superficial resemblance to the upper molars of *Anoplotherium commune*, especially noticeable in the incompleteness of the crescent formed by the first inner column, which thus makes an approach to the separation of this column into two distinct portions, as is the case in *Anoplotherium*. The molar of *Hemimeryx* is, however, readily distinguished from that of *Anoplotherium* by the absence of the isolated pillar on the hinder side of the first inner column, as well as by the greater lateral curvature and obliquity of the external surfaces of the outer columns, and by the incompleteness of the horse-shoe-like connecting loop.

Lower molar.—In figure 1 of plate XXIII. there is represented a nearly complete left lower molar, from the lower Manchhar rocks, evidently belonging to some species of selenodont pig, and from its size provisionally referred to the present species: it is the specimen alluded to on page 79 of the XIth volume of the "Records." The tooth is in a very early stage of wear, the outer columns being scarcely touched: the two hinder columns are somewhat broken. It is distinguished from the lower molars of *Merycopotamus* by the crown being lower, by the transverse valley being nearly

blocked, instead of freely open, on the inner side, and by the inner columns being flatter and less completely conical; this flatness is especially noticeable on the inner side. The specimen more nearly resembles the lower molar referred to *Hyopotamus palæindicus* (pl. XXIII, figure 3; *this figure is viewed more from the external aspect than figure 1*), but is distinguished by the columns being much narrower and sharper, and the median valley narrower and deeper: there is also a more distinct 'cingulum' on the anterior aspect. The dimensions of the specimen are as follows:—

	In.
Length (of two columns)	0.9
Width	0.6
Height of antero-internal column	0.5

Distribution.—No other remains have hitherto been discovered which can be referred to this species, which is thus confined to Sind. It is much to be hoped that other remains may eventually be discovered, which will further elucidate the affinities of this and the following interesting forms.

GENUS IV: SIVAMERYX,¹ n. gen. *nobis*.

Species: SIVAMERYX SINDIENSIS. *nobis*.

Upper molar.—In figure 11 of plate XXIII there is represented, from the masticating surface, the single upper molar on which this genus is founded, the only previous notice of which will be found on page 80 of the XIth volume of the "Records," where the name was proposed. The tooth is an almost unworn specimen from the right maxilla, and was obtained by Mr. F. Fedden from the lower Manchhars of Sind: it is quite perfect. An inspection of the figure will show that the tooth clearly belongs to the present group of animals, *viz.*—tetracuspitate selenodont pigs. There is, however, in the structure of the tooth an approach to the molars of the pentacuspitate group which has not been observed in any other genus; it also makes a further step in the direction of the more generalised forms of the true ruminants, than the molar of *Hemimeryx*, but still preserves the open valleys, and the complete union of the bases of the outer columns, characteristic of the selenodont pigs. On the anterior side of the specimen (*right side of figure*) the ridge leading from the inner column carries, near the transverse valley, a small triangular process (*not very clearly shown in the figure*), touched by wear before the inner column, and evidently the representative of the fifth column of the *Anthracotheridæ*. The two inner columns are more developed on the side of the middle valley than in the allied genera: there is a well-marked crenulated 'cingulum' on three sides. Without further describing the tooth in detail, it will suffice to point out in what respects, in addition to the presence of the rudimentary fifth column, it differs from the molars of the allied genera. The tooth, except in the absence of the fifth column, presents some resemblance to the molars of *Hyopotamus crispus*,² and may have belonged to

¹ From *Siva* (or properly *Shiva*) the Hindu deity whose name forms the root of the word Sivaliks (Sivaliks), and *méryx*.

² Gervais, "Zoologie et. Paléontologie Françaises," 2nd ed., pls. XXII., fig. 7: XXXII., fig. 9.

an animal connecting that somewhat abnormal form with the tetracuspitate selenodont Suina: it is, however, distinguished by the form of the external surfaces of the outer columns. Irrespective of its considerably smaller dimensions, the tooth differs from the upper molar of *Hemimeryx* (plate XXIII, figure 5), by the much greater development of the vertical ridges on the external surfaces of the outer columns; by which means the external surface of the second outer column (*left-hand top corner of figure 11*) has its middle line as high as its right side, whereas in *Hemimeryx* the corresponding surface (*right-hand top corner of figure 5*) is most markedly concave. The antero-internal lobe is, moreover, considerably more complex than in *Hemimeryx*.

From the molars of *Merycopotamus*, the tooth before us differs very widely, not only in size, but also in structure. The outer columns have their external surfaces placed less obliquely to the vertical axis of the crown, and their lateral borders are not so much produced above the middle line. The loop connecting the outer columns is relatively larger and more compressed laterally: the external surfaces of the outer columns are wider, and so-to-speak, less squeezed together.

The tooth is larger than the molars of *Charomeryx* and differs by having the valleys wider and more open, by the more compressed form, and less outward development of the loop connecting the outer columns, and also by the form of the external surfaces of the outer columns, as can be seen by a comparison of the figures. The specimen makes some approach to the molars of *Dicrocerus*,¹ but is distinguished by the incompleteness of the inner 'crescents,' by the outward extension of the transverse valley, and by the longitudinal valley being quite open.

The tooth before us does not seem to approach to any other described form, and it seems, therefore, necessary to refer it provisionally to a new genus, for which the above title, with the specific name of *sindiensis* may be adopted.

Other remains.—As is mentioned in the "Records,"² Mr. Fedden has also obtained a lower molar, and the hinder portion of a cranium of a small animal allied to *Merycopotamus*, which may not improbably belong to the present species: both specimens came from the lower Manchhars of Sind. The tooth is of much the same form as the specimen represented in plate XXIII, figure 1, but is of smaller size: it does not present any characters of generic value, and, therefore, is not figured. The portion of the cranium comprises only the cerebral box, and as it has been much rolled and otherwise damaged, it has not been figured. It agrees in relative size with the upper molar, and as far as can be determined, presents a general resemblance to the skull of *Merycopotamus*; the cerebral box is, however, more compressed laterally. Further comparisons are impossible owing to the imperfect condition of the specimen.

¹ "Les Enchainements du Monde Animal, etc.," p. 97, fig. 120.

² Vol. XI, pl. 80.

FAMILY 3.—*OREODONTIDÆ*.

Characters.—This family, taken here as comprehending the genera *Oreodon*, *Epooreodon*, *Agriochærus* and *Merychochærus*, is distinguished from the last by the mandible lacking the characteristic descending plate at the 'angle,' and by the nearer approach in the plan of structure of the molars to the true ruminants. The family has hitherto been recorded only from the tertiaries of north America, but the molar tooth described below would seem to indicate that it formerly existed in north-western India. It will be remembered that in the previous volume of this work,¹ it was pointed out that the lower molars of the extinct Siwalik camel present a remarkable affinity to those of the American cameloid *Auchenia*, and since the oreodons are considered to be intimately connected with the tertiary ancestors (*Procamelus*, etc.,) of the modern camels, it is a fact of much interest to find that the Siwalik camel lived in a country which had also a representative of the oreodons and agriochærus.

GENUS AGRIOCHÆRUS,² Leidy.

As the reference of the molar described below to this genus is merely provisional, the generic characters are not given. The genus is stated to have relationship with *Hypotamias*.

Species, *non. det.*

Upper molar.—The specimen provisionally referred to the above genus is an, unfortunately incomplete, upper molar; it is represented from the masticating surface in figure 2, of plate XXIII, and will be seen to belong to the left side of the cranium. This tooth has been scarcely affected by wear, but has lost a part of its postero-internal column, as well as the external walls of both the outer columns. It was collected in 1878, by Mr. F. Fedden, in the lower Manchhars of the Lâki Hills of Sind.

The crown carries only four columns without the slightest trace of the fifth accessory column. The inner columns are stout and low; rounded and conical on their inner, and regularly crescentic on their outer sides: they are more symmetrical than those of any of the previously described genera. The median longitudinal valley is deeper and more distinct than in the preceding genera, whereby the outer columns are more widely separated from the inner, and are not thrust within their crescents. The two outer columns are closely approximated at their bases, so that there could not have been a wide transverse valley terminating externally in a projecting loop. The external surfaces of the outer columns were probably nearly vertical, and not produced at their angles, as in the preceding genera. There is a

¹ p. 61.

² From, *agrios*, wild, and *choiros*, a pig. This genus is generally, as here, classed with the *Oreodontide* (see Nicholson's "Palæontology," 2nd ed., p. 352), but Professor Leidy is inclined to refer it to a distinct family, (see "Contributions to Extinct Vertebrate Fauna of Western Territories," p. 216.)

well-defined 'cingulum' on the internal surface of the one complete inner column which now remains. The length of the specimen is 0·58 inch, and the height of its outer column 0·34 inch.

Comparisons.—There can be no question as to the generic distinctness of the tooth under consideration from the molars of the other Siwalik selenodont pig-like animals; neither can it be identified with those of any European representative of the same group. Turning, however, to the American *Oreodontidae*, the tooth will be found to resemble very closely in general structure the molars of the genera *Oreodon*,¹ *Eporeodon*, *Agriochærus*, and *Merycochærus*.² A comparison of the specimen with the admirable figures of the molars of these genera given by the transatlantic palæontologists, as well as with actual specimens and casts in the British Museum, has shown that the resemblance is so close that there seems no doubt but that the Indian specimen should be referred to some member of the same family. The molars of *Oreodon* (*Eporeodon*) *major* seem, except in the matter of size, to come very close to the Indian tooth: the form of the 'cingulum' and inner columns being strikingly similar in both. In the matter of size, the Indian specimen comes nearer to the molars of *O. culbertsoni*,³ but in those teeth the valleys are less completely open. The nearest approach to the Indian tooth seems, however, to be made by the teeth of *Agriochærus latifrons*. If the figure given in this memoir be compared with the very excellent woodcut of an upper molar of the latter species, given (after Professor Leidy) by Professor Gaudry, on page 98 of the oft-quoted "Enchainements du Monde Animal," it will be seen that (as far as the imperfect condition of the Indian tooth will permit of comparison,) there is an almost, if not complete, identity between the two specimens, and they might very readily be taken for the teeth of the same species. The absence of the external surface of the Indian tooth renders it uncertain whether the form of this part would be precisely the same as the American tooth, and as there appears to be some difficulty in always distinguishing isolated teeth of *Agriochærus*, *Oreodon* and *Merycochærus*, it would not be safe to identify the Indian tooth with *A. latifrons*, though it would be unwise to say that it might not belong to that species. It seems, however, certain, as already said, that the tooth belongs to the *Oreodontidae*, and it is accordingly provisionally referred to the genus *Agriochærus*, with the possibility of its belonging to the American species *A. latifrons*. With this possibility in view no specific name is assigned to the Indian tooth, and it must also be borne in mind that there is a further possibility that the generic determination may eventually be proved incorrect, though this is improbable.

¹ Leidy *loc. cit.*, pl. VII., fig. 7 to 12.

² *Ibid.*, figs. 1 to 6.

³ *Ibid.*, fig. 12.

SECTION : RUMINANTIA.

? FAMILY.—*PALÆOMERYCIDÆ*.GENUS : *PROPALÆOMERYX* n. gen. *nobis*.

As this provisional genus is founded on a single molar, its characters may be gathered from the following description of that specimen.

Species : *PROPALÆOMERYX SIVALENSIS*, *nobis*.

Upper molar.—In a paper by the writer, styled a "Sketch of the History of the Fossil Vertebrata of India,"¹ it is stated that "a single molar in the Indian Museum seems to indicate a Siwalik representative of the genus *Paleomeryx*." The specimen on which this statement rests is figured in the accompanying woodcut: it cannot be said that it properly belongs to the subject of the present fasciculus, but it does not come very inappropriately after the more ruminant-like *Suina*, and as it has some connection with teeth described in the preceding fasciculus, it has been found convenient not to postpone its description. The specimen² is from the sub-Himalayan Siwaliks, and was formerly in the Rürki Museum, whence it was transferred by exchange to the Indian Museum.



Fig. 2. *Propaleomeryx sivalensis*; left upper true molar—Siwaliks—near Rürki.

The specimen is a perfect upper molar of the left side, in an intermediate stage of detrition. The figure will at once show that it belongs to a member of the true ruminant section, although the lowness of the crown, and the width and shallowness of the central 'pits' indicate that it belongs to one of the primitive and little specialised members of that section. The structure of the enamel, which is faintly rugose, and the oblique position of the external walls of the 'lobes,' indicate affinity with the *Camelopardalidæ*, *Cervidæ*, and their allies.

The 'crescents' are separated far down into the crown, and the first of these (*left side of figure*) is unsymmetrical, being produced on its anterior side. The external walls of the 'lobes' are set more nearly in the same line than in *Camelopardalis* (plate XVI of preceding part, figs. 1 and 2), which character, together with the finer structure of the enamel, and the imperfect 'cingulum' which is seen on the anterior 'crescent,' distinguishes the tooth from the molars of the last named genus. There is no trace of any tubercle at the entrance to the median transverse valley. There is a distinct 'costa' on the outer surface of the anterior 'lobe,' but none can be detected on the posterior 'lobe.'

The tooth, as already said, certainly does not belong to *Camelopardalis*, neither does it belong to *Orasius* of Wagner. The crown seems too low and the central 'pits' too shallow for it to have belonged to any of the true *Cervidæ*.

On the whole the specimen appears to come nearest to the upper molars of *Paleomeryx bojani*³ of the European miocene. There are no specimens of the molars

¹ J. A. S. B., Vol. XLIX, pl. 2, p. 28.

² No. B. 337, Ind. Mus.

³ H. von Meyer, "Fossile Zähne von Georgensmünd," 1834, pl. IX., fig. 75: pl. X., fig. 79.

of this form in the British Museum, but by the courtesy of Professor Gaudry an opportunity has been afforded of comparing the Indian tooth with a specimen of the upper molar series of that species from Sansan, in the Paris Museum (No. 5954). The Sansan teeth are much less worn than the Indian tooth, but allowing for this difference, there is a very close general resemblance between the two specimens. The Sansan teeth are, however, distinguished by having the 'costæ' on their external surfaces, more prominently developed, by the presence of a distinct 'cingulum,' and a large tubercle at the entrance of the median transverse valley. The central pits seem rather wider and shallower. In the structure of the enamel, and in size, the specimens are very similar.

Another European species, *P. emineus*,¹ from the miocene of Eningen, is of nearly the same size as the Indian tooth, but is apparently only known by the mandible.

There can be no question that the Indian tooth is not specifically the same as *Palæomeryx bojani*; and, taking into consideration the small differences in the molar teeth of ruminants which are of generic value, it seems highly probable that it should be referred to another genus. Its general resemblance to *Palæomeryx* is, however, so great that it almost certainly belongs to some closely allied form, and as it cannot be identified with any other known genus, the provisional generic name of *Propalæomeryx* is proposed for its reception, with the specific affix of *sivalensis*.

Lower molar?—It is just possible that the last lower molar represented in figure 6 of plate XVI of this volume, and referred to *Camelopardalis sivalensis*, together with a similar specimen described in the text, may belong to the present species, the resemblance of the Indian upper molar and the upper molars of *Palæomeryx bojani* to those of *Camelopardalis* being so great, that it is very probable there might be considerable difficulty in always separating the lower molars of these forms.

Judging from the teeth alone, it is probable that the larger species of *Palæomeryx* and the new genus *Propalæomeryx* were close links between *Camelopardalis* and the true *Cervide*. If the 'costæ' of the molars of *Palæomeryx bojani* were slightly less developed, the 'cingulum' and tubercles suppressed, the 'pits' a little deeper, and the enamel a little more rugose, it would be very difficult to distinguish them from those of *Camelopardalis*.

¹ Meyer, "Paläontographica," Vol. II, p. 78, pl. XIII, fig. 5.

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"Eocäne Säugethiere aus dem Gebiete des Schweizerischen Jura," 'Nov. Mem. Soc. Hel.,' vol. XIV, (*Hypopotamus greslyi*).

"Über Anthracotherium magnum, und *A. hippoideum*," 'Nov. Mem. Soc. Hel.,' vol. XV.

"Über Schweizerische Anthracotherien," Basel, 'Verhandlungen,' 1857, p. 517.

(In these memoirs references are given to the earlier memoirs on the genus.)

ADDENDUM.

From the miocene of Switzerland are named two little known species of *Anthracotherium*, viz. *A. valdense*, Kow., and *A. lukarpi*, Renev.: they are probably synonyms of the species given in the list on pages 7-8.¹

¹ See O. Heer, "Die Urwelt der Schweiz," 2nd ed., p. 713.

- HOERNES, R. "Sur Kenntniss des *Anthracotherium dalmatinum* v. Meyer." 'Verh. k. k. geol. Reichs.,' 1876, p. 363.
- MEYER, H. VON. "Über *Anthracotherium dalmatinum*," 'Paläontographica,' vol. IV.
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- "Über Schweizerische Anthracotherien." 'Verh. nat. Ges. Basel,' 1857, p. 517.

ADDENDUM TO ANTHRACOTHERIUM.

Third Siwalik species.—Since the text was printed another fragment of the



Fig. 3. *Anthracotherium* sp. (cf. *A. magnum*, Cuv.); part of left ramus of mandible; Dera Búgti (Indian Museum, No. B. 432). $\frac{1}{2}$.

mandible of an anthracotheroid, obtained by Mr. Blanford from the lower Siwaliks (Mauchhars) of Dera Búgti, N.E. Balúchistán, has come into the writer's hands, and is figured in the accompanying woodcut. It belongs to the left side of the jaw, and shows $m.3$ in a much worn condition. The specimen differs from either of the mandibles represented in plate XXV. by its larger size, and by the form of the inferior border; which below

$m.3$ is straight, instead of being convex with a notch below the third lobe of the tooth. The present specimen was apparently furnished with a descending expansion behind $m.3$. These differences are so important as to leave no doubt that the specimen is specifically distinct from either of the other mandibles.

Compared with *A. magnum* and *A. hippoideum*,¹ it will be found that the inferior border of the present specimen is very similar to the same part in those species.

¹ Rüttimeyer, 'Nov. Mem. Soc. Hel.,' vol. XV., pl. I

While, however, the mandible of *A. hippoideum* is smaller, one of *A. magnum* figured by Prof. Owen¹ and De Blainville² has almost precisely the same dimensions as the present specimen; while a comparison of the latter with a cast of the former has shown that no points of distinction can be drawn between them. Other specimens of *A. magnum* are, however, somewhat larger. As the present specimen is too large to have belonged to either of the anthracotheroids of which the upper molars are figured in plate XXIV. (to which the mandibles figured in plate XXV. are provisionally referred), it seems to indicate a new Indian species of the group. Its resemblance to *A. magnum* is so close as to render it certain that it belongs to that genus, and possibly to that species, although the specimen is too imperfect to decide the latter point. The dimensions of the specimen are as follows, viz. :—

Depth at third lobe of m. 3	2.7	Length of m. 3	2.7
" " first " " " "	2.7	Width " " " "	1.33

It may be added that the mandibles figured in plate XXV. indicate forms not closely allied to *A. magnum* or *A. hippoideum*. The range in time of the former species in Europe is from the upper eocene (Quercy phosphorites) to the lower miocene.³

Additional European species.—In mentioning the number of species of *Anthracotherium* on page 148 an important paper by Prof. Renevier, cited in the foregoing list, had escaped the writer's notice. In this paper the species *A. valdense*, Kow, and *A. luharpei*, Ren., are described and figured; while *A. minus*, Cuv., is admitted as a species. All three species, which have been obtained from the Swiss miocene, must be added to the list given on pp. 149-9, bringing the number of well-authenticated species to eleven.

The only one of these species coming near to either of the Siwalik species is the form referred to *A. minus*,⁴ which is nearly the same size as *A. silistrense*. The upper molars have, however, a more distinct cingulum, with the inner columns more markedly crescent-shaped: the mandible is, moreover, of a more slender type; while the lower molars have a very conspicuous cingulum.

¹ 'Quart. Journ. Geol. Soc.,' vol. IV., pl. VIII., fig. 6.

² "Ostéographie," Genus *Anthracotherium*, pl. III.

³ On page 149 the range in time of this form is given, through an oversight, as upper eocene only.

⁴ Renevier, *op. cit.*, pl. VI., figs. 72, 73.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA CARNIVORA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES XXVI. TO XLV.)

ORDER: CARNIVORA.

FAMILY 1.—*MUSTELIDÆ*.

The family *Mustelidæ*, comprehending the weasels, badgers, and otters, constitutes "a large, widely diffused, and somewhat disjointed group, but exceedingly difficult to reduce into natural sub-families. The most aberrant or specialized are the otters, which ending with *Enhydriæ*, run parallel to the Bears towards the Pinnipedia." For the purpose of the present memoir it will suffice to divide this family into two sub-families; *viz.*, the *Mustelinæ* comprehending the weasels, the glutton, the badgers, etc.; and the *Lutrinæ*, or otters.

SUB-FAMILY A.—*MUSTELINÆ*.

Genera.—The only genera of this sub-family which it will be necessary to mention for the purposes of this memoir, are the following, arranged in the order adopted in the catalogue of the osteological collection of the Royal College of Surgeons. The number of cheek-teeth in each genus is given after the name, *viz.*:

Gulo	pm. $\frac{4}{2}$	m. $\frac{3}{2}$	Taxidea	pm. $\frac{3}{2}$	m. $\frac{1}{2}$
Galictis ²	" $\frac{3}{2}$	" "	Moles	" $\frac{2}{2}$	" "
Ictonyx	" "	" "	Mydams	" $\frac{3}{2}$	" "
Helictis	" $\frac{4}{2}$	" "	Arctonyx	" $\frac{4}{2}$	" "
Mellivora	" $\frac{3}{2}$	" $\frac{1}{2}$	Mephitis	" $\frac{3}{2}$	" "
Conepatus	pm. $\frac{3}{2}$	m. $\frac{3}{2}$			

There is really no well-marked distinction between this group of genera and the more typical weasels; but since it is only to certain of the genera mentioned in this list that the fossil forms described below can have any affinity, it is unnecessary to allude further to the other genera of the family. In the genera mentioned the number of true molars is, with one exception, $\frac{1}{2}$; but this exception renders the only constant numerical

¹ Flower.

² Synonyms *Grisonia* and *Galera*.

character of the cheek-teeth the presence of but a single true molar in the upper jaw. In all the genera the lower carnassial ($\overline{m.1}$) is characterized by its great relative length; and the premolars, are generally sub-conical teeth with the fore-and-aft talons very slightly developed. The mandible of the larger and stronger forms is in general characterized by its relative shortness and depth, and the straightness of its inferior border.

There is a considerable degree of variation in the development of the upper carnassial ($\overline{pm.4}$) relatively to the other cheek-teeth in the different genera. In some forms (*Meles*, *Arctonyx*, *Conepatus*) this tooth is much shorter than the true molar ($\overline{m.1}$), whence the upper dentition may be termed *meionocreodont*.¹ In other genera (*Helictis*, *Taxidea*, *Mydaus*, *Mephitis*) $\overline{pm.4}$ is about equal in size to $\overline{m.1}$, whence these genera may be termed *mesocreodont*. In the remaining genera (*Gulo*, *Galictis*, *Ictonyx*, *Mellivora*) $\overline{pm.4}$ is much longer than $\overline{m.1}$, whence they may be termed *megaloreodont*. In the meionocreodont forms the lower carnassial ($\overline{m.1}$) is relatively longer than in the megalocreodont forms, being developed in correspondence with the increased relative size of the upper true molar ($\overline{m.1}$) in the former. The ratel and the badger afford extreme examples of this difference; the length of $\overline{m.1}$ in the former being about $1\frac{1}{2}$ times that, of $\overline{pm.4}$, whereas in the latter it is nearly $2\frac{1}{2}$ times the length of $\overline{pm.4}$. The glutton is intermediate in this respect, the length of $\overline{m.1}$, being nearly twice that of $\overline{pm.4}$. Generally it seems that in the meionocreodonts the length of $\overline{m.1}$ is more than twice that of $\overline{pm.4}$, whereas in the megalocreodonts the length of the former is never more, and may be considerably less than twice that of the latter.

For the purposes of the present memoir the most important dental character is that while in *Gulo* and *Mellivora* the hinder talon of the lower carnassial is bluntly trenchant, in all the other forms this part is hollow, and surrounded with a rim, or ridge of cusps: this character is most marked in *Meles*, *Taxidea*, *Arctonyx*, *Mydaus*, and *Ictonyx*.

Fossil forms.—The above-mentioned group appears to be extremely poorly represented in previous geological epochs, the only fossil forms, except those described below, with which the author is acquainted, being the existing *Gulo luscus* and *Meles taxus* from the pleistocene of Europe; a species of *Galictis* and *Mephitis* from the caverns of Brazil; *Palaeomephitis* and *Promephitis* from the upper tertiary of Europe; and one species of *Taxidea* from the pliocene of North America, described by Professor Cope under the name of *T. sulcata*. As the Indian fossil forms described below belong to the genus *Mellivora* and an allied genus, for which the term *Mellivorodon* is proposed, it will be seen that the geographical distribution of the fossil forms in many cases agrees very closely with that of their living representatives.

¹ These terms will be more fully explained in the sequel: they are compounds of "creodont" = "flesh" or "carnassial-toothed," and are intended to indicate the relative size of the "flesh" or "carnassial tooth."

GENUS. MELLIVORA, Storr.

Synonyms. *Ratelus*, Ben¹ *Ursitaxus*, Hodgson.

General.—The dentition of the genus has been already alluded to under the head of the sub-family. At the present time a living representative of the genus is found throughout India, known as *M. indica*, while another form occurs in Africa, which has been named *M. capensis*. Dr. Sclater has, however, come to the conclusion¹ that it is extremely doubtful whether the Indian and Cape ratels can be specifically distinguished, since an African form described by him when young under the provisional name of *M. leuconota*, when adult could scarcely be distinguished from *M. indica*. There do not appear to be any well-marked characters by which the skulls of the Indian and African forms can be distinguished. It is believed that the two Siwalik species described below are the only fossil representatives of the genus.

Species 1. MELLIVORA SIVALENSIS, (Falc. and Caut.)

Synonyms. *Ursitaxus sivalensis*, Falc. and Caut.*Gulo*, sp., Baker and Durand.

History.—The first mention of the specific name of this species appears to be in the posthumous description of the supplemental plates of the "Fauna Antiqua Sivalensis,"² where a very perfect cranium is figured (pl. Q., figs. 4, 4a, 4b, 4c) under the name of *Ursitaxus sivalensis*. This specimen is now in the British Museum (No. 40,184), and is one of two skulls and a mandible obtained from the typical Siwaliks of the neighbourhood of the Ganges valley, and originally figured and described in the "Journal of the Asiatic Society of Bengal"³ by the late Cols. (then Lieuts.) Sir W. E. Baker and Sir H. M. Durand under the name of *Gulo*,—the living ratels being then referred to that genus. The second skull and the ramus of the mandible are now in the Science and Art Museum in Dublin; by which institution, in company with several other fine remains of Siwalik carnivora, mostly from Messrs. Baker and Durand's collection, they are stated to have been purchased many years ago from a Dr. Beattie.⁴

At a later date a fragment of the mandible of a ratel from the Siwaliks of the Punjab was briefly described by the writer, and referred to the present species.⁵ It will, however, be shown below that this specimen belongs to a distinct species. These four specimens are the only known fossil remains of the genus, and form the subject of the present notice.

Cranium.—In plate XXVI. of the present memoir the four figures of the cranium given in the "Fauna Antiqua Sivalensis" have been copied: they represent

¹ 'Pro. Zool. Soc.' 1871, p. 232.² See "Paleontological Memoirs," vol. I., p. 553.³ Vol. V., p. 581, plate XXVII., figs. 4-8—1836.⁴ These two specimens bear the number 45.⁵ "Rec. Geol. Surv. India," vol. XI., p. 102.

the cranium from the superior, lateral, posterior, and inferior aspects, and are drawn of the natural size.¹

With the exception of a crushing-in of part of the frontals, this skull is singularly perfect, and a glance at the figures will immediately show that it belongs to the genus *Mellivora*. Speaking of their two skulls Messrs. Baker and Durand remark that "the two fossils, though differing considerably from each other, agree in the following points of dissimilarity from the recent skull [*Mellivora indica*]. Their canine teeth are larger and stronger, and their tubercular molars smaller; the two lines of molars converge towards the muzzle considerably less in the fossil than in the recent animal, and the individual false molars [premolars] are set less obliquely to the line of the maxillary. The frontal is wider between the orbits; the post-orbital apophyses more prominent and the depression of the cranium in rear of them less deep; the exterior portion of the mastoid process has a far greater development [well shown in figure 2]; the transverse occipital ridge is thicker, more rugged and more prominent, and projects considerably beyond the plane of the occiput in the prolongation of that of the parietal bones."

The following table gives the dimensions of the two skulls described by Messrs. Baker and Durand, partly taken from their memoir; and also those of the skull of a very old individual of the living Indian species, in the collection of the writer: the measurements of the dentition of two other specimens, from the collection of the Royal College of Surgeons, are also given:—

	Fossil species.		M. indica.		
	Dublin.	Brit. Mus.	<i>collo nostra</i> .	R.C.S. 744	R.C.S. 742
Length from occipital condyle to incisors	5.51	5.08	5.35		
Breadth at mastoid process	3.26	3.1	3.19		
Greatest breadth of brain box	2.44	2.41	2.5		
Height of occiput	1.69	1.74	1.78		
Interval between paroccipital processes	1.99	2.0	1.98		
Greatest zygomatic breadth	2.99	2.85	2.91		
Interval between outer surfaces of canines	1.31	1.2	1.3		
" " widest part of molar series	1.87	1.65	1.9		
Antero-posterior diameter of base of canine	0.39	0.34	0.36	0.34	0.38
Length of molar series	1.28	1.18	1.26		
" " pm. 2	0.27	0.25	0.23	0.24	0.25
" " 3	0.39	0.36	0.34	0.32	0.38
" " 4	0.56	0.52	0.52	0.48	0.56

The slightly larger size of the Dublin skull, of which the right side of the palate is figured in the woodcut on the next page (fig. 1, a), in the absence of other points of distinction, does not seem indicative of more than individual, or sexual, variation. The table of dimensions shows how extremely close is the general resemblance between the recent and fossil skulls; the most important differences being the considerably greater development in the fossil form of the mastoid portion of the petiotic. The Dublin specimen, which is not improbably

¹ It is stated in the "Paleontological Memoirs" that this skull corresponds to figure 5 of Messrs. Baker and Durand's memoir: it really corresponds to figure 7.

that of a male, also shows that the fronto-parietal region is flatter and more depressed, and the sagittal crest wider and stouter than in the living species: the latter character is also partly shown in the figures of the British Museum specimen. The larger size of the canines in the fossil, mentioned by Messrs. Baker and Durand, is not so well marked, as was at first supposed. In the fossils, pm. 2 and pm. 3 are slightly larger than in the recent form. The true molar (m. 1) of the former differs from that of the latter by being much less expanded at its inner extremity.

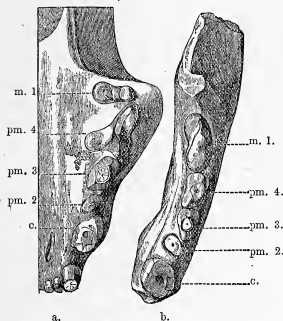


Fig. 1. *Melivora sivalensis*, (F. and C.) The right half of the palate (a), and the left ramus of the mandible (b): from the Siwalik specimens in the Dublin Museum: nat. size.

in the accompanying woodcut (fig. 1, b). From its size and mineralogical character this specimen probably belonged to the same individual as the skull in the same collection. Speaking of this jaw Messrs. Baker and Durand remark that the measurements of the "recent and fossil jaws exhibit no difference save in the canine teeth, which severally correspond with the same teeth in the upper jaw. There is, however, in the fossil a deep depression in the ramus, which in the recent species is nearly flat." The depression alluded to is the masseteric fossa, which in the fossil is narrow and well defined, but in the recent species broad and indistinct. The most important distinctive point of the fossil is, however, the disposition of the cheek-teeth, which in place of forming a nearly straight line, in continuation of the canine, are convex externally, the canine being placed on the inner side of the line: this is in correlation with the lesser inclination of the line of the upper cheek-teeth, noticed by Messrs. Baker and Durand. In most other respects the form of the recent and fossil jaws is exceedingly alike: their dimensions are compared in the following table:—

	Fossil.	Recent.		
		<i>collis nostris</i> .	R.C.S. 744.	R.C.S. 722.
Length from condyle to anterior border of canine	. . . . . 3·2 ..	5·28		
" " " " hinder m. 1	. . . . . 1·48 ..	1·45		
Space occupied by cheek-teeth and canine	. . . . . 1·77 ..	1·95		
Interval between hinder border of m. 1 and canine	. . . . . 1·42 ..		1·28	1·42
Depth at m. 1	. . . . . 0·67 ..	0·68		
Length of pm. 2	. . . . . 0·22 ..	0·21	.. 0·22	.. 0·2
" " 3	. . . . . 0·32 ..	0·29	.. 0·26	.. 0·28
" " 4	. . . . . 0·38 ..	0·39	.. 0·38	.. 0·44
" " m. 1	. . . . . 0·53 ..	0·59	.. 0·54	.. 0·59
Antero-posterior diameter of canine	. . . . . 0·39 ..	0·38	.. 0·32	.. 0·38

† The specimen has now lost the condylar portion, as also the crown of the canine, which is complete in Baker and Durand's figure. Somewhat similar damage has befallen the Dublin skull.

These dimensions show that in the fossil $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ are more nearly equal in size than in the recent species; $\overline{\text{pm. 3}}$ being relatively smaller in the recent species, while $\overline{\text{pm. 4}}$ is as large, or larger, than in the fossil. This difference causes $\overline{\text{pm. 3}}$ to overlap $\overline{\text{pm. 2}}$ in the latter, while in the recent species the one tooth is entirely behind the other. The lower carnassial ($\overline{\text{m. 1}}$) is relatively larger in the recent form; and accordingly this tooth overlaps $\overline{\text{pm. 4}}$, which is not the case with the fossil. There is also a more distinct 'diastema' in the latter.

Precisely similar conditions are observable in the mandibular dentition of *Mellivora capensis*,¹ except that sometimes $\overline{\text{pm. 3}}$ is overlapped by $\overline{\text{pm. 4}}$; the great difference in size of these teeth is, however, most marked.

Conclusions.—The foregoing observations leave not the slightest doubt but that this species of Siwalik ratel is specifically distinct from the living Indian species; and as no important points of distinction have been recorded between the skulls and dentition of the latter and the living African form, which, as already mentioned, is regarded by Dr. Selater as not improbably the same as the Indian, it follows that the fossil must also differ from the former,² and may, therefore, be entitled to rank as a distinct species, for which the name *Mellivora sivalensis* may advantageously be retained. It is uncertain whether this or the next species should probably be regarded as the direct ancestor of the living forms, but it is not impossible, from the greater difference in the size of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ that the second species should occupy this position. In any case it is highly probable that India should be regarded as the original home of the genus.

Distribution.—The three specimens described above are the only known remains of this species, and were all obtained from the neighbourhood of the Ganges valley. It would be unsafe to make any very definite conclusions from the occurrence of these three specimens, but as another species of the genus inhabited the Punjab in Siwalik times, it is possible that the range of the present species may have been confined to the eastern side of India.

Species 2: MELLIVORA PUNJABIENSIS, n. sp.: nobis.

History.—As already mentioned, a lower jaw of a Siwalik ratel from the Punjab was briefly noticed by the present writer some years ago in the "Records," and referred to *M. sivalensis*. A comparison of this specimen with the Dublin mandible of the latter has, however, shown conclusively that the former belongs to a distinct species, and it is on that specimen that the present species is founded.

Mandible.—The above-mentioned specimen is represented in figures 6 and 6a of plate XXVII. of the present memoir:³ it consists of the anterior part of the right

¹ Owen, "Odontography," pl. CXXVIII., fig. 10.

² Owing to there being no skull of that species in the Museum of the Royal College of Surgeons, and to the British Museum osteological collection being at present inaccessible, the author has had no opportunity of comparing the fossils with *M. capensis*.

³ The author only knew of the existence of the Dublin mandible after this plate was lithographed: otherwise the two specimens would have been figured side by side.

ramus of the mandible, and was obtained by Mr. Theobald in the Siwaliks of the village of Asnot, in the Punjab; and is now in the Indian Museum. The ramus is complete from the symphysis nearly to the hinder border of the carnassial; it shows the broken bases of two incisors, and of the canine; the alveolus of $\overline{\text{pm. 2}}$; the nearly perfect $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$; and the base of the carnassial ($\overline{\text{m. 1}}$), imperfect posteriorly. The shape of the jaw and the number and form of the cheek-teeth conclusively show that the specimen belongs to a species of ratel of about the same dimensions as the living species and *M. sivalensis*, and it, therefore, remains to show its distinctness from these species. The following table gives the dimensions of the mandible of the three forms:—

	Specimen. 1-91 (?)	M. indica. 1-85	M. sivalensis. 1-74
Space occupied by cheek-teeth and canine	1-45 (?)	1-4	1-37
Ditto by cheek-teeth	0-95	0-9	0-94
Interval between carnassial and canine	0-78	0-68	0-67
Depth at $\overline{\text{m. 1}}$	0-42	(0-32) 0-38	0-39
Ant-posterior diameter of canine		0-21 (0-22)	0-22
Length of $\overline{\text{pm. 2}}$	0-25	(0-26) 0-29	0-32
" " 3	0-36	0-30 (0-44)	0-38
" " 4	0-56 (?)	(0-54) 0-50	0-53
" " $\overline{\text{m. 1}}$	0-32	0-28	0-23
Interval between $\overline{\text{pm. 3}}$ and canine			

These dimensions show that the specimen is distinguished from the mandible of *M. sivalensis* (woodcut, fig. 1, b) by the great difference in the size of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$; the former tooth being smaller than in the living species, whereas in *M. sivalensis* it is larger. The two fossils must also have been distinguished by the distinct interval which in the specimen under consideration must have existed between $\overline{\text{pm. 2}}$ and $\overline{\text{pm. 3}}$. Both fossils agree, and thereby differ from both the living species, in there being no overlap of $\overline{\text{pm. 4}}$ by $\overline{\text{m. 1}}$. The carnassial of the Punjab jaw must have been about equal to the average size of that of the living Indian species; but the canine is stouter than in the latter, or *M. sivalensis*. As regards the shape of the jaw itself the specimen under consideration is widely distinguished from the mandible of the latter by the line of the cheek-teeth being nearly a direct continuation of that of the inner side of the canine, without any outward curvature: this causes the outer surface of the jaw to be concave, in place of convex, and the outer surface of the canine to be placed far externally to the outer line of the premolars, instead of considerably on the inner side of the same. These differences are so great as apparently to leave no doubt that the Punjab mandible is specifically distinct from *Melliivora sivalensis*.

With regard to *M. indica*, the specimen under consideration is distinguished in the first place by the relatively larger size of the canine, and the smaller size of $\overline{\text{pm. 3}}$. Both agree in the straight line formed by the cheek-teeth, but the canine is placed more externally in the fossil: in the latter, moreover, the outer surface (plate XXVII., fig. 6) is concave antero-posteriorly below the premolars, in place of being flat, while the inner surface of the same (*ibid.*, right side of fig. 6a), in place of

swelling out suddenly below the premolars, descends nearly vertically below them. In all these respects, indeed, the fossil under consideration differs as widely from *M. indica* in one direction, as *M. sivalensis* does in the other, and leads to the conclusion that it must be specifically distinct from both. From the locality whence it was obtained it is proposed to name this new species *Mellivora punjabiensis*.

From the lower premolars of this species being more like those of *M. indica*, and from the direction of the molar series being approximately the same in the two species, it is perhaps, as already said, more likely that the present species, rather than *M. sivalensis*, should have been the ancestor of the living rats.

Distribution.—No more can be added regarding the distribution of the present species to what has been stated in relation to the distribution of *M. sivalensis*.

GENUS II.: MELLIVORODON, n. gen. *nobis*.

The characters of this genus, as far as they are at present known, will be given under the head of the one species.

Species: MELLIVORODON PALÆINDICUS, *nobis*.

History.—The new generic term *Mellivorodon* is applied here for the first time; one of the specimens (pl. XXVII., fig. 7, 7a) on which the genus is founded has been, however, briefly noticed by the present writer and doubtfully referred to the genus *Meles*.¹

Mandible.—The specimens on which the new genus is founded consist of two fragments of the mandible, represented from their outer sides in figures 7 and 8 of plate XXVII.; the dental aspect of the former specimen being represented in figure 7a. Both specimens were collected by Mr. Theobald in the Siwaliks of the Punjab; the former having been obtained at the village of Asnot, and the latter at the village of Niki. The specimen represented in figure 7 comprises the anterior portion of the ramus, broken off anteriorly in front of the canine, and posteriorly at the hinder extremity of the carnassial. The teeth shown in this specimen are, firstly, the broken base of the canine (fig. 7a: c), which is of very large size; behind this there is the base of a very small $\overline{\text{pm. 2}}$, filling up the interval between the canine and $\overline{\text{pm. 3}}$: the base of this tooth is very indistinct and scarcely visible in the figure. The third premolar ($\overline{\text{pm. 3}}$) has only its base remaining, but of the fourth tooth of that series the nearly perfect crown, slightly abraded at its summit, still remains: $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ are nearly equal in length. The carnassial ($\overline{\text{m. 1}}$) is an elongated tooth, imperfect superiorly and posteriorly. The second specimen (fig. 8) shows the hinder extremity of the horizontal ramus, broken off posteriorly at the 'angle.' This fragment shows the complete crown of the carnassial ($\overline{\text{m. 1}}$), with the blade slightly broken, and behind the carnassial the empty alveolus of the second true molar ($\overline{\text{m. 2}}$). Although this specimen is slightly larger than the other, the dimensions and form of the carnassial, and of the mandible below it, are precisely similar to the corresponding

¹ 'Records,' vol. XI., p. 102.

portions of the specimen represented in fig. 7, and there is accordingly every probability that they belong to the same species. Taking the two specimens together, they afford an idea of the form of the nearly complete mandible, and indicate that the number of the lower cheek-teeth of the species to which they belonged was $\overline{\text{Pm. 3}}$. $\overline{\text{M. 2}}$.

The relative stoutness of the fossil jaws, the straightness of their inferior border, and the simple sub-conical form and absence of accessory talons from $\overline{\text{pm. 4}}$, leaves little doubt that the specimens belong to the above-mentioned group of the *Musteline*. This is confirmed by the relatively large size of the canine, of which, as in the allied living genera, the antero-posterior diameter of the base considerably exceeds the length of $\overline{\text{pm. 4}}$; whereas in the typical weasels, the dogs (generally distinguished by the presence of $\overline{\text{pm. 1}}$), and the *Viverridae* (with the exception of *Arctictis*), which are the only other families to which the fossil could belong, the antero-posterior diameter of the base of the canine appears to be always shorter than the length of $\overline{\text{pm. 4}}$. The specimens under consideration may, therefore, be taken as belonging to the above-mentioned group of *Musteline*. The form of the hinder talon of the carnassial, which is fortunately preserved in the specimen represented in figure 8, shows that the summit of that part was bluntly trenchant; whence the animal was evidently closely allied to the glutton and the ratel. From the latter the fossil is distinguished by the presence of $\overline{\text{m. 2}}$; by the equality in the size of $\overline{\text{pm. 4}}$ and $\overline{\text{pm. 3}}$, and by the minuteness of $\overline{\text{pm. 2}}$. From the lower jaw of *Gulo* the fossil is distinguished by the absence of $\overline{\text{pm. 1}}$, by the minute size of $\overline{\text{pm. 2}}$, and by the thinner form of the carnassial. As these two genera appear to be the only large-sized representatives of the group with a trenchant hind talon to the carnassial, it seems practically certain that the specimens under consideration must be referred to a new genus. From the resemblance in the general form of the teeth to those of *Mellivora* the generic title of *Mellivorodon* is proposed, to which may be appended the specific name *palæindicus*.

In the following table the measurements of the two specimens under consideration are compared with the corresponding dimensions of the mandible of *Mellivora indica*, and *Gulo luscus* :—

	Gulo.	Mellivorodon.		Mellivora indica.	
		fig. 7.	fig. 8.		
Length of carnassial	0.95	.. .. (2) 0.73	.. 0.9	.. ..	0.59
" " $\overline{\text{pm. 4}}$	0.46	.. .. 0.4			0.36
" " " 3	0.36	.. .. 0.39			0.29
" " " 2	0.3	.. .. 0.15			0.21
Ant. post. diam. of canine	0.55	.. .. 0.5			0.39
Interval between carnassial and canine	1.08	.. .. 1.03			0.9
Depth of jaw at m. 1	1.16	.. .. 0.88	.. 1.0	.. ..	0.68

These measurements indicate that *Mellivorodon* was intermediate in size between the ratel and the glutton; while the form and relative proportions of its teeth indicate that it was more nearly allied to the former than to the latter.

SUB-FAMILY B.—*LUTRINÆ*.

According to the system adopted here, this sub-family includes only two or three genera, viz., *Enhydris* (*Enhydra*), *Lutra*, and perhaps *Lutrielis*. As all the specimens described here are referred to the second genus, the dental characters of that genus alone need be referred to.

GENUS: *LUTRA*, Ray.

INCLUDING *Aonyx*, *Barangia*, *Hydrogale*, *Lutax*, *Loutra*, *Lutroneetes*, *Nutria*; Gray.

Enhydriodon (*Amyxodon*), Falconer.

Dental characters.—The only points in connection with the skeletal anatomy of the otters that it will be necessary to notice on this occasion are some connected with the dentition. Generally in the true otters the adult dental formula is as follows, viz., I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{3}$, M. $\frac{1}{2}$. In some forms, however (*Aonyx*), the first upper premolar is either not developed, or is shed at an early period, and the formula then becomes I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{3}{3}$, M. $\frac{1}{2}$. The molar series differs from that of more typical mustelines "in the increased development of the tubercular [m. 1] of the upper jaw, and in the greater degeneration, so to speak, of the carnassier [carnassial (pm. 4)]. The typical tubercle on the inside of the latter, instead of being limited to a small knob connected with the body by a narrow base, constitutes nearly half of the surface of the coronal [crown], and is expanded into a wide disc, bounded on its inner side by a sharp raised edge, occupying the whole length of the inside of the tooth. The outline of the carnassier is in consequence nearly triangular. The body [blade] is still distinctly tricuspid, as in the higher [feline] carnivora, but the anterior cusp is reduced to little more than a well-marked serrature or lobe of the basal ridge. The tubercular [m. 1] has a development proportionate to that of the tubercle of the carnassier. It is somewhat trapezoidal in the outline of its coronal, which is oblong in the transverse direction, that is considerably broader than long; it is divided lengthwise by a deep hollow into two somewhat unequal halves, the outer and smaller of which is subdivided by a shallow transverse channel into two



Fig. 2. *Lutra* (*Aonyx*) *hyip/aonyx*, Horsf. Upper dentition, nat. size: from a recent specimen in the author's possession, from India. The uppermost tooth is the tubercular (m. 1), and the tooth below it the carnassial (pm. 4): pm. 1 is wanting.

flattish surfaces bounded by a raised edge; while the inner is expanded into a flat disc, bounded by an edge, as in the tubercle of the carnassier, but it is of greater extent and more complicated in form. This arises from the anterior border of the coronal being raised up into a prominent trenchant ridge divided into two denticles, and distinct from the bounding

basal ridge which sweeps round it."¹ The foregoing description is taken from some typical form like *Lutra vulgaris*,² but there are some slight modifications among the existing true otters, although according to Dr. J. Anderson³ the teeth of all the above-mentioned so-called genera into which Dr. Gray subdivided the old genus *Lutra*⁴ do not offer a single character of generic value. There are, it is true, in some forms external characters like the lateral expansion of the tail in *Lutra* (*Pteronura*) *sandbachii*, and the smallness of the claws in *Lutra* (*Aonyx*) *leptonyx*, which may be of generic value. As, however, these are inapplicable in the case of fossils, in which the teeth and skull alone have generally to be relied upon, it follows that at least for palæontological purposes all the living forms must be included under one genus. In the Indian short-clawed otter *Lutra leptonyx* (woodcut, fig. 2) and other species belonging to the same sub-genus, the palate is relatively short and the molars relatively large, and the inner half of m. 1 is the longest part of that tooth, while in most other forms the outer half of that tooth is longer than the inner. In *L. canadensis*, however, the proportions of that tooth are the same as in *L. leptonyx*. In species like *Lutra vulgaris* in which the true molar is considerably broader than long, the tubercular part of the carnassial is comparatively small, leaving a large vacuity between it and the true molar; but in forms like *Lutra* (*Aonyx*) *leptonyx* the squareness of the true molar, and the larger size of the tubercular portion of the carnassial leave very little space between these two teeth. These characters are well displayed in the figure in the "Histoire Naturelle des Mammifères,"⁵ and may also be observed by comparing the woodcut figure 2 with figure 1 of plate XXVII. of this memoir. There is, however, among the living species an almost complete transition between the extreme forms of variation in the proportionate size of the molar teeth.

It will be shown below that there is a more important variation in some of the fossil forms, but these will be best noticed in the description of the species themselves.

Turning to the lower dentition it will be found that in typical forms "the tubercular is of comparatively small size, nearly square, and its coronal divided by a transverse low ridge into two flattened nearly equal surfaces. The carnassier may be considered as made up of two parts; separated by a deep transverse hollow, the anterior of which is formed of three sub-equal pointed cusps disposed in a triangle, the inner representing the tubercle of the corresponding upper tooth; the posterior portion consists of a dilated flattened tubercle, sloping inwards, and bounded by a sharp edge, which is raised at the outer side into an obsolete posterior cusp, less distinctly marked at the inner side."⁶

In all living forms the outer pair of incisors of both jaws is slightly larger than the two inner pairs.

¹ Falconer, "Palæontological Memoirs," vol. I., p. 332. ² Blainville, "Ostéographie" Genus Mustela, pl. VIII.

³ "Anatomical and Zoological Researches, etc., in Western Yunnan," London, 1878, p. 200.

⁴ "Cat. of Carnivora, etc., in the British Museum," p. 100, *et. seq.* ⁵ P. Gervais, Paris, 1845, p. 116,—woodcuts.

⁶ Falconer, *loc. cit.*

Living Indian and adjacent species.—In the present state of science it would be almost a hopeless task to give a correct list of the existing species of otters; it will, however, probably suffice for the purposes of this memoir to mention the best known species of India and the adjacent countries. According to Dr. Anderson¹ it appears that there are four species of Himalayan and Indian long-clawed otters, viz.:—

LUTRA AUROBRUNNEA. Hodgs.

LUTRA ELLIOTI.

LUTRA NAIR. F. Cuv.

L. indica. Gray.

L. tarayensis. Hodgs.

L. chinensis. Gray.

LUTRA SIMUNG. S. Raffles.

*L. monticola.*² Hodgs.

It is, however, incidentally mentioned (p. 211) that *Lutra vulgaris*, Erxl, probably occurs in Káshmir, and it is not improbable that this form may occur in the more inner Himalaya,³ as it certainly does in Persia.⁴

LUTRA SUMATRANA, Gray. Inhabits the Malay peninsula.

There is, moreover, one species, belonging to the sub-genus *Aonyx*, distinguished by its short claws, viz.:—

LUTRA LEPTONYX. Horsf.

Aonyx horsfieldi. Gray.

Aonyx sikimensis. Hodgs.

(?) *Lutra indigitata.* Hodgs.

(?) *Lutra swinhoei.* Gray.

In Dr. Gray's Catalogue of the Carnivora in the British Museum, and in the new Osteological Catalogue of the Museum of the Royal College of Surgeons, the range of *L. leptonyx* is given as Java and Sumatra. Dr. Anderson, however, considers this form to be the same as the Himalayan *L. indigitata*, Hodgs., and the Indian *H. horsfieldi*, Gray; it is, however, suggested that the short-clawed otter of Ceylon may be distinct: the same view is entertained by Dr. Jerdon.

Of these species the skull of *L. aurobrunnea*, which is a small species, is according to Dr. Anderson unknown, and the present writer has not met with a figure of that of *L. ellioti*. In *L. nair*,⁵ and *L. simung*,⁶ which are both of large size, the true molar is relatively large and subquadrate. In *L. sumatrana*,⁷ which is also of large size, this tooth is very short antero-posteriorly; and the same is the case in the skull of *L. vulgaris* figured by De Blainville.⁸ In *L. leptonyx* (woodcut, fig. 2), as

¹ *op. cit.*, p. 213.

² This species was identified by Jerdon with *L. vulgaris*, and it is so classed in the new catalogue of the Museum of the Royal College of Surgeons: it is, however, distinguished by the greater proportionate size of pm-4.

³ W. T. Blandford, "Scientific Results of 2nd Yarkand Mission—Mammalia," Calcutta, 1879, p. 32.

⁴ W. T. Blandford, "Zoology and Geology of Eastern Persia," London, 1876, p. 43.

⁵ Anderson, *op. cit.*, pl. XI., fig. 3.

⁶ *Ibid.*, pl. XII., fig. 2.

⁷ *Ibid.*, pl. XII., fig. 5.

⁸ "Ostéographie," Genus *Mustela*, pl. VIII.

already mentioned, the last molar is subquadrate, and longer internally than externally. A species of otter from Borneo, said to be distinguished from *L. sinung* by its shorter tail is mentioned by Dr. Günther,¹ but the characters of the skull are not given.

Fossil species.—The following list gives the best defined fossil forms, exclusive of the Indian species described below :—

1. *LUTRA BRAVARDI*,² Pom. Pliocene, France.

(?) *L. clermontensis*, Blain (in part).

(?) *L. claverus*, Croiz.

A species said to be rather larger than *L. vulgaris*, in which the true molar is subquadrate.

2. *LUTRA AFFINIS*,³ Gerv. Pliocene, France.

Very doubtfully distinct from *L. vulgaris*.

3. *LUTRA CAMPANI*,⁴ Meneghini. Mid. miocene, Tuscany.

A very large species, whose dental characters will be alluded to below. The Monte Bamboli beds, from which this fossil was obtained, are classed by Prof. Gaudry below the Sansan stage (mid. miocene).

4. *LUTRA DUBIA*,⁵ Blain. Mid. miocene, Sansan.

A species apparently only known by a fragment of the mandible, of considerably larger size than that of *L. vulgaris*.

5. *LUTRA LORTETI*,⁶ Filhol. Miocene, France.

A species known by a portion of a mandible, somewhat smaller than that of *L. vulgaris* : $\overline{m.2}$ has only one root as in *L. leptonyx*.

6. *LUTRA PISCINARIA*,⁷ Leidy. Pliocene, N. America.

A species named from a single tibia.

7. *LUTRA VULGARIS*, Erxl. Recent, Palearctic : pleistocene, Europe.

L. antiqua. Marcel de Serres.

Mustela lutra. Lin.

It may be added that the so-called *Lutra valetoni*⁸ (E. Geof.) of the French miocene belongs to the genus *Lutricetus*, distinguished from all other mustelines by the presence of a minute second upper true molar, and from the otters by the whole of the premolars being placed posteriorly to the canine.⁹ This genus which evidently belongs to the *Mustelidae*, although it is somewhat doubtful whether it should be placed in the sub-family *Lutrinae*, is considered by Professor Gaudry to form a connecting link between the *Mustelidae* and the *Viverridae*.

Species 1. *LUTRA PALEINDICA*. Falc. and Caut.

History.—Although no description of this species was ever published by Dr. Falconer, there is not the slightest difficulty in identifying the specimens to which

¹ "Pro. Zool. Soc.," 1876, p. 736.

² Gervais, "Zoologie et Paléontologie Françaises," 2nd ed., p. 244, pl. XXVII., fig. 6 (palate).

³ *Ibid.*, p. 244. ⁴ Meneghini, "Atti. del. Soc. Ital. d. Sci. Nat.," 1862, vol. IV., p. 18, pl. IIA.

⁵ Blainville, "Ostéographie" Genus *Mustela*, pl. XIV.

⁶ Filhol, "Notes sur Quelques Mammifères Fossiles de l'Époque Miocene," Lyon, 1881, pl. IV., figs. 20-2.

⁷ Leidy, "Extinct Vertebrate Fauna of Western Territories," p. 316, pl. XXXI., fig. 4.

⁸ *Potamotherium valetoni*, E. Geof., *Lutra clermontensis*, Blain. (in part), *Stephanodon monbecheiensis*, H. Myr.

⁹ See Gaudry, "Les Enchaînements du Monde Animal, etc.—Mammifères Tertiaires," fig. 200.

the name (which occurs in manuscripts of Dr. Falconer in the British Museum) was applied, as these, consisting of a skull, and a part of a mandible, are in the collection of the British Museum, where they are labelled *Lutra palaeindica*. These two specimens are moreover figured in the "Palæontological Memoirs,"¹ and in the unpublished plates of the "Fauna Antiqua Sivalensis."² The first published mention of the name appears to have been in the former work. At a later date (1879) Mr. P. N. Bose³ gave a brief description of these specimens under the same name, and apparently came to the conclusion that they could not be identified with any described species.

Cranium.—A view of the palatal aspect of the above-mentioned cranium is given in figure 1 of plate XXVII. of the present memoir; and this and other views are also given in plate P. of the "Fauna Antiqua Sivalensis." The specimen has lost both zygomatic arches, a part of the occiput and of the right maxilla, but is otherwise fairly complete: it shows the alveoli of the three incisors, and of the first three premolars of the left side: $\overline{\text{pm.4}}$ and $\overline{\text{m.1}}$ of the same side are still remaining. The specimen was obtained in the typical Siwalik Hills, and, as already said, is now in the collection of the British Museum (No. 37,151): the dentition shows that it belonged to a fully adult individual.

There can be no question but that the skull belongs to a true otter, and it will accordingly be the simplest plan to point out in what respects it differs from such of the living otters of India and the neighbouring countries of which figures or specimens of the skull are available, and subsequently to compare it with the fossil species mentioned above.

In the first place it may be observed that the elongated form of the skull, and the shape of the hinder cheek-teeth, shows that the specimen has no affinity with the short-clawed Indian otter, *Lutra (Aonyx) leptonyx* (compare plate XXVII., fig. 1, with woodcut fig. 2), as is shown by the following measurements:—

	<i>L. palaeindica</i> .	<i>L. leptonyx</i> .
Length from foramen magnum to incisors	3·57 ..	3·2
" of palate	2·04 ..	1·7
Greatest width of ditto	1·25 ..	1·32

Comparing the fossil skull with the skull of those species of existing Asiatic otters in which it is known it will be found that in *Lutra nair*⁴ and *L. vulgaris*⁵ the skull is longer and proportionately wider: in both the existing forms the length of the palate is almost exactly the same as that of the fossil species, but its width is considerably greater. In comparing the fossil with the skull of the "living Indian otter," by which it is presumed that *L. nair* is referred to, Mr. Bose⁶ observes that "the skull of the fossil is smaller, and the teeth proportionately larger. The brain-case is broader and higher in the fossil than in its living representative. But the most characteristic feature in the fossil skull is the form of the forehead. In the

¹ Vol. I., pl. XXVII., figs. 6-8.

² Plate P., figs. 1, 2.

³ Quar. Jour. Geol. Soc., vol. XXXVI., pp. 133-4.

⁴ Anderson, *op. cit.*, pl. XI., fig. 3.

⁵ Blainville, "Ostéographie," Genus Mustela, pl. VIII.

⁶ *op. cit.*, p. 133.

common [*L. vulgaris*], as well as in the Indian otter, the frontal narrows from behind the post-orbital process, in the shape of a triangle, up to its junction with the brain-case proper; but in the fossil the part between the post-orbital processes of the frontal and the cranial cavity is wider and is of uniform breadth throughout, so as to be quadrangular instead of triangular." This shows (the specimen being fully adult) that the fossil belonged to one of the smaller weak-jawed otters (like *Lutra leptonyx*), in which (as in the smaller *Canidae*) the temporal ridges never unite in the middle line to form a sagittal crest (as in *L. vulgaris*), but remain permanently separate, and enclose a persistent 'sagittal area,' as the intervening space is termed by Professor Huxley.

In *L. sumatrana*¹ the palate is absolutely both shorter and wider than in the Indian fossil. The narrower form of the skull and the lesser development of the tubercular portion of the carnassial distinguishes the latter from *L. sinung (monticola)*.²

It appears, therefore, that the fossil skull is distinguished from the skulls of such of the existing species of India and the adjacent countries, of which the skulls are known, by its much narrower form. It does not appear, moreover, that any existing species from other countries agrees in this respect with the fossil. The whole length of the latter is 3.57 inches, while that of a full-grown male skull of *L. nair* is 4.07 inches. The fossil, therefore, belonged to a rather small species of otter, which from the elongated form of the skull may be pretty safely referred to the long-clawed, or typical, division of the genus.

With regard to the various fossil species given in the foregoing list it will be found that the specimen under consideration differs from *L. bravardi* by its generally smaller size, by its much narrower palate, and by the shortness of the true molar. From *L. affinis* the Indian fossil must be distinguished by the characters distinguishing it from *L. vulgaris*. With *L. campani*, as will be apparent in the sequel, the present specimen has not the slightest affinity; and it must be considerably smaller than *L. dubia*. The distinction of the specimen from *L. lorteti* will be noticed under the head of the mandible. As *L. piscinaria* is described merely upon the evidence of the tibia, there are no means of comparing it with the Indian fossil.

From the foregoing comparisons it will be seen that this form of Siwalik otter cannot be identified with any other described form, and is, therefore, entitled to rank as a distinct species. As already said, its affinities appear to be nearer to the long-clawed, than to the short-clawed otters, but there are no characters indicating special relationship with one species more than another.

Mandible.—In figures 2 and 2a of plate XXVII. of the present memoir there is represented the left ramus of the mandible of an otter from the Siwaliks, originally drawn in plate P., figure 2, of the supplemental plates to the "Fauna Antiqua Sivalensis," and referred by Dr. Falconer to his *Lutra palceindica*: it is now in the British Museum (No. 37,152). There is no evidence to show whether this specimen

¹ Anderson, *op. cit.*, pl. XII., fig. 5.

² *Ibid.*, pl. XII., fig. 2.

was associated with the skull described above, but from the similarity in the mineralogical characters of the two specimens it is very probable that such was the case. Whether this be so or not, the proportionate size of the skull and mandible is such that there is little or no doubt that they belong to the same species.

The mandible shows the whole of the horizontal, and a considerable portion of the ascending ramus. It also exhibits a portion of the canine (c), the roots of three premolars (pm. 2, 3, 4), the carnassial (m. 1), with the hindmost outer cusp of the blade broken off, and the alveolus of m. 2 (imperfectly shown in the figure). The specimen presents a strong general resemblance to the mandibles of *L. nair*, and *L. vulgaris*, but is of somewhat smaller size. It is only necessary to compare it with the mandible of the miocene *L. lorteti*, already referred to, from which it is widely distinguished by the much greater length of the carnassial, and by the curved form of the inferior border.

Distribution.—The two specimens above described are the only known remains of the species: they were both obtained from the Siwaliks of the neighbourhood of the Ganges valley. It would, however, be unsafe to infer that the range of the species was limited to that district.

Species 2. *LUTRA BATHYGNATHUS*, n. sp. *Nobis*.

History.—In the ninth volume of the "Records"¹ the present writer made mention of a fragment of the mandible of an otter obtained by Mr. Theobald in the Siwaliks of the Punjab, of larger size than the mandible of *Lutra palvindhica*, which was thought might belong to a distinct species. It is upon this specimen that the present species is mainly established.

Mandible.—In figures 3 and 3a of plate XXVII. the above-mentioned specimen is represented; figure 3 being taken from the inner side, and figure 3a from the dental aspect. The specimen is a left ramus of the mandible, showing nearly all of the horizontal portion. Posteriorly it shows the carnassial (m. 1), of which the hinder cusps of the blade have been broken off: in advance of this is the base of the last premolar (pm. 4). Between the latter and the fragment of the canine (c) still remaining, there are five dental alveoli, belonging to the first, second, and third premolars (pm. 1: pm. 2: pm. 3): the first of these teeth must have been inserted by one fang, and each of the others by a pair of fangs. Behind the carnassial the alveolus of the second true molar is probably concealed by matrix. The form of this jaw and its dentition leaves not the slightest doubt that it belongs to a species of otter.

In figure 4 of the same plate there is represented, from the inner side, another fragment of the left ramus of the mandible of an otter, also collected by Mr. Theobald in the Siwaliks of the Punjab. This specimen shows the hinder portion of the horizontal ramus, and a considerable portion of its inferior border: it also

¹ p. 104.

exhibits the alveolus of the second true molar (m. 2). A comparison of this specimen with the one represented in figure 3 shows that the two evidently belonged to the same species of animal; the portion common to the two (*viz.*, that immediately behind the carnassial) being absolutely identical: both specimens present the well-marked muscular impression, characteristic of the otters, immediately behind the last molar.¹

In the following table the dimensions of the specimen represented in figure 3 are compared with those of the mandibles of *L. palaeindica* and of the living *L. simung*² :—

	Fig. 3.	<i>L. palaeindica</i> .	<i>L. simung</i> .
Interval between canine and hinder border of m. 1	1.55	1.2	1.46
Length of m. 1	0.69	0.52	0.64
Depth of jaw at m. 1	0.79	0.48	0.45

These figures show that the jaw under consideration is distinguished from the other mandibles not only by its superior size, but also by the much greater proportionate depth of the jaw itself. In the species selected for comparison, and apparently in all other living otters, with one exception, the depth of the jaw is considerably less than the length of the carnassial (m. 1); whereas in the specimen under consideration the reverse is the case.

The large living South African *Lutra (Aonyx) lalandi* (Less)³ appears, however, to differ from all other living otters by the great depth of the mandible, which exceeds the length of the carnassial, as is shown by the following measurements, which are compared with those of the specimen represented in figure 3 :—

	<i>L. lalandi</i> .	Fig. 3.
Interval between canine and hinder border of m. 1	1.58	1.55
Length of m. 1	0.7	0.69
Depth of jaw at m. 1	0.76	0.79

These measurements show how extremely close the fossil and recent jaws are to one another. Comparing the figures given here with those given by De Blainville, it will be found that the inner view of the hinder part of the mandible represented in figure 4 corresponds with De Blainville's outline figure of the same aspect. A comparison of the outer side of the former specimen with De Blainville's figure of the same has shown that the two are almost identical, the sudden upward direction of the inferior border of the ramus behind the last molar (not well shown in the position of the figure of the fossil) being the same in both, and apparently quite peculiar to these two forms. The fossil seems, however, to be distinguished from the recent form by the more outward inclination of the ascending ramus, and by the more distinct notch separating the hinder border of this ramus from the inner angle of the condyle, but there is no doubt that the two forms are very closely allied.

With regard to the other fossil forms of the genus the only species of those given in the list on page 190 with which, on account of their size, the specimens

¹ The specimen represented in fig. 4 should have been figured with the hinder (condylar) extremity more elevated.

² Anderson, *loc. cit.*, pl. XII., fig. 1.

³ De Blainville, "Ostéographie," Genus *Mustela*, pl. VIII, (*Lutra inunguis*).

under consideration can have any affinity is *Lutra campani*. The lower jaw of that form is, however, unfortunately unknown, but from the fact that pm.1 is absent, it may be inferred that the corresponding tooth in the lower jaw would probably be likewise wanting, which is not the case in the specimens under consideration. The only remaining fossil form to which these specimens could possibly belong is the species described below under the name of *Lutra sivalensis*, of which the upper dentition is figured in plate XXVII, figure 5. The lower jaws are, however, too small to have belonged to that form, as is shown by the lower molar series being considerably shorter than the upper; the reverse being the case with all species of otters. There is another reason why these specimens should not belong to the same species;—namely, that in *L. sivalensis* the first upper premolar is absent, whereas the whole series is present in the lower jaw.

Conclusions.—From the foregoing comparisons it appears that the only otter to which the specimens under consideration are allied is the South African *L. lalandi*; the resemblance between the former and the mandible of the latter being indeed so close that it is very difficult to fix on any differences of specific value: such, however, might probably be found if additional remains of the fossil were attainable. As it is highly improbable that the two forms are absolutely identical it seems better to assign a distinct provisional specific name to the fossil form; and the term *bathynathus*, in allusion to the most marked character of the mandible, is accordingly proposed.

It is a fact of extreme interest to find one of the Siwalik otters presenting no sort of affinity with any of the existing Indian species, but very closely allied to a living South African species, of which it is highly probable that it is the direct ancestor. This relationship affords another well-marked instance of the intimate connection of the tertiary fauna of India with the present African fauna.

Distribution.—The two specimens above described, both obtained from the Punjab, are the only known remains of the species. As remains of *Lutra palæindica* are known only from the more easterly Siwaliks it is possible that these two species lived on the opposite sides of India, although considering the paucity of their remains it is hazardous to draw any very positive conclusions.

Species 3. *LUTRA SIVALENSIS*, (Falc. and Caut.)Synonyms. *Enhydriodon sivalensis*, F. and C.,, *ferox*, F. and C.*Amyxodon*, sp., F. and C.

History.—In a memoir written in 1843, but not published till 1868, after his death,¹ Dr. Falconer described certain remains from the Siwaliks, of a lutrine animal 'as large as a panther,' under the new generic name of *Enhydriodon*,² which was to replace the name *Amyxodon* which had previously been applied to the same remains, without description.³ In the memoir on *Enhydriodon* no specific name was applied to the specimens described. In the description of the supplemental plate P. of the "Fauna Antiqua Sivalensis,"⁴ probably taken from Dr. Falconer's notes, the specimens, which are there figured, are named *Enhydriodon ferox*. In the "Palæontological Memoirs," however, the specimens are figured (plate XXVII.) under the name of *Enhydriodon sivalensis*; and it is said⁵ that the specimens (now in the British Museum) were so labelled by Dr. Falconer, after the lithographing of the plate in the "F.A.S." If this be so, it seems that the name *sivalensis* was intended to be used by Dr. Falconer, and as it is preferable to *ferox* it seems on the whole better to adopt it.⁶ In the original memoir there are indications that Dr. Falconer considered that there were two species of the genus; but no specimens of the second and smaller form are now forthcoming.

It will be shown in the sequel that with the materials now available (which are more complete than those accessible to Dr. Falconer), the teeth of the Siwalik fossil do not appear to afford sufficient grounds for separating it generically from the true otters; and it will accordingly be referred to the genus *Lutra*, with the specific title of *sivalensis*.

Cranium.—In his original memoir Dr. Falconer described three portions of the cranium of the so-called *Enhydriodon*, all of which are now in the British Museum, and are figured, of the natural size, in plate P. of the "Fauna Antiqua Sivalensis,"

1 "Palæontological Memoirs," vol. I., p. 331.

2 This name is derived from *Enhydria*, the Greek name for the otter, and as the name of the living sea-otter (*Enhydria* or *Enhydra*) is derived from the same word, it has been considered by some (the writer among the number) that the name *Enhydriodon* was intended to signify that the genus was allied to *Enhydria*. This, however, Dr. Falconer expressly states is not the case ("Pal. Mem.," vol. I., p. 332, note). On account of this tendency to mislead the name *Enhydriodon* is an exceedingly objectionable one.

3 "Jour. Asiat. Soc. Bengal," vol. IV., 1836, p. 707, and Royle, "Illustrations of the Botany, etc., of the Himalaya Mountains," vol. I., p. 31.

4 "Palæontological Memoirs," vol. I., pp. 552-3.

5 *Ibid.*, p. 331, note.

6 The author must plead guilty to having previously used these names somewhat indiscriminately.

and also, of about half the natural size, in plate XXVII. of the first volume of the "Palæontological Memoirs." In addition to these specimens there is a specimen of the facial portion of the skull in the Museum of the Royal College of Surgeons, obtained from the Siwaliks, and presented by the late Rev. R. Everest. This specimen (by the permission of the Curator of the Museum) has been (for the first time) figured from the palatal aspect in figure 5 of plate XXVII. of the present memoir; and since its cheek-teeth are in better preservation than those of any of the other specimens, it is mainly these teeth that are compared with those of other species of otters.

It may be observed in the first place that all the four skulls exhibit essentially lutrine characters;—more particularly the shortness of the facial portion of the skull, the post-orbital contraction of the frontals, the sudden lateral expansion of the brain-case, and the enormous relative size and extreme shortness of the infra-orbital foramen for the passage of the fifth nerve ("Pal. Mem.," pl. XXVII., fig. 1). The skulls show a considerable amount of variation in the relative degree of development of the sagittal crest, probably indicating differences of sex and age in the different specimens. In the specimen figured in the present memoir this crest is very prominently developed; whence it may probably be inferred that the skull belonged to a fully adult male. The same may also be affirmed of the skull represented in figure 5 of the above-mentioned plate of the "Palæontological Memoirs"; whereas the other two skulls in the same plate probably belonged to female individuals. The skull represented from the palatal aspect in figure 4 of the same plate, which is the only one with the brain-case, shows that the auditory bulla was triangular and depressed, as in the living otters.

The state of preservation of the crania is not sufficiently perfect to admit of any closer comparisons; but there are no indications of any characters generically different from those of the living otters.

Upper dentition.—In the specimen represented in figure 5 of plate XXVII. there are shown the complete true molars and carnassials of each side: there are also shown the bases of pm.3, but no traces of pm.2. The alveoli of the canines, and of the three incisors are also shown: the latter somewhat indistinctly. In the specimen represented in figure 2 of the above-mentioned plate of the "Palæontological Memoirs" the alveoli of pm.2 are distinctly shown.

The complete dentition is, therefore, numerically the same as that of the otter represented in the woodcut (fig. 2) on page 187. Commencing with m.1, it will be found that this tooth has precisely the same form as the corresponding tooth of the otter represented in figure 1 of the same plate, which has been shown to be related to the long-clawed otters. The cusps on this tooth correspond precisely to the cusps of the tooth of the otter figured on page 187. In the carnassial (pm.4), however, there are very considerable differences from the corresponding tooth of all living otters. To illustrate more fully these differences, the left upper carnassial, partly

broken on the outer side, of one of the above-mentioned skulls in the British Museum ("Pal. Mem.," *loc. cit.*, fig. 5) has been figured in the accompanying woodcut (fig. 3).¹ A comparison of this woodcut and of the figure of *pm. 4* in plate XXVII., figure 5, with the corresponding tooth of the otters given in figure 1 of the same plate, and in the woodcut on page 187, will show that the inner or tubercular part of this tooth, in place of consisting of a single unbroken semicircular trenchant ridge, consists of three distinct cusps, or mammillæ, placed on the line of a semicircle, and of which the median cusp is much smaller than either of the other two. The blade, or outer part, of the carnassial is constructed on the same general plan in the recent and fossil forms; but in the latter the anterior cusp, which is very minute in the former, becomes much more developed, and thereby gives to this part of the crown a distinctly tricuspid form. In the form of the outline of its base the crown of this tooth differs but little from the carnassial of *Lutra leptonyx* (p. 187), which was shown to differ from the corresponding tooth of the long-clawed otters by the larger size of the tubercular portion: the carnassial of the fossil Siwalik form is in this respect only one more step in the relative degree of development of the tubercular portion.



Fig. 3. *Lutra (Enhydriodon) sivalensis*: left upper carnassial, broken on the outer side, from a skull in the British Museum (No. 37,155) from the Siwaliks: nat. size.

The differences indicated above between the form of the carnassial in the fossil and the living otters, if no intermediate form existed, might be sufficient to indicate generic distinction between the two. It happens, however, that such an intermediate form exists in *Lutra campani* of the miocene of Monte-Bamboli in Tuscany. This species was described in 1862 by Professor G. Meneghini² on the evidence of two specimens of the palate. Of one of these specimens³ there is a plaster cast in the British Museum, from which the right carnassial tooth has been figured in the accompanying woodcut (fig. 4). This tooth belongs to the opposite side of the skull to the tooth of *Lutra sivalensis* figured in the previous woodcut (fig. 3), but corresponds to the carnassial (*pm. 4*) on the right side of the figure of the palate in plate XXVII., figure 5. Owing to the distorted condition of the palate to which it belongs, it has been figured with its outer ridge (*right side of figure*) running nearly parallel to the long diameter of this page, in place of inclining from the north-east to the south-west angle. It will be seen that the blade of this tooth resembles that of the carnassial of the living otters, in having only a very minute anterior cusp. The inner, or tubercular portion, of the crown, in place of bearing a completely semicircular ridge joining the blade at both extremities, merely carries a curved ridge, with a distinct cusp, or tubercle, at its anterior extremity (*left lower*



Fig. 4. *Lutra campani*. Mgh. Right upper carnassial, from the cast of a palate in the British Museum (No. 37,347) from the miocene of Monte-Bamboli, in Tuscany: nat. size.

At the time this woodcut was drawn the author was not aware that the College of Surgeons specimen showed the unbroken carnassials.

² 'Atti. del. Soc. Ital. di. Sci. Nat.', vol. IV., pl. I., p. 18.

³ Figure 1 of Professor Meneghini's plate.

angle of figure): this ridge and cusp are separated from the blade by a distinct open valley. The anterior cusp corresponds precisely to the anterior cusp of the tubercular portion of the carnassial of *L. sivalensis*, while the ridge corresponds to the united middle and hinder cusps of the latter. In the second specimen figured by Professor Meneghini¹ the tubercular portion of the carnassial has two distinct cusps, connected by a very low ridge, and agreeing precisely in position with the two main cusps on the tubercle of the carnassial of *L. sivalensis*. The carnassial of *L. campani*, in its two varieties, affords, therefore, a complete transition between the corresponding tooth of *L. sivalensis* and *L. leptonyx*; the latter passing on to the carnassial of the long-clawed otters (e.g., *L. palaeindica*).

Leaving m. 1 and pm. 4, attention may now be directed to the anterior teeth of *Lutra sivalensis*. None of the four specimens of the skull show the complete pm. 3; but the base of this tooth is shown in the specimen figured in this memoir. In spite of the opinion expressed by Dr. Falconer to the contrary, this tooth appears to be very similar to the corresponding tooth of the living otters, having a similar strongly developed cingulum: its main cusp is, however, not improbably slightly lower. The second premolar, as already observed, has been shed in the skull figured in this memoir, but its minute alveolus exists in one of the skulls in the British Museum: this tooth is present in the palate of *L. campani*. None of the skulls show any trace of pm. 1, which is also absent in *L. campani*.

With regard to the incisors, Dr. Falconer's original description may be quoted in full. He observes "The incisors are of the normal number, three on each side, the two interior of which are shown by their transverse section to have been very compressed, their length being three times their width. This compression, so much greater than what is seen in either *Lutra* or *Enhydra* [*Enhydris*], or in any other described *Mustelidae*, is palpably connected with the enormous development of the outer incisor on either side, which relatively exceeds that of any known Carnivora. This lateral incisor evidently served as a subsidiary canine, and the only analagous case which occurs to us is found in a very different family, the Ruminantia, where the upper lateral incisor puts on the form and development of a canine in the Camel. In one of the specimens ["Pal. Mem." *loc. cit.* fig. 2.] the base of this tooth, with the other incisors, remains in the jaw, broken off on a level with the alveolus, and enables us to determine its relative size with precision. The section of the fang shows a very broad oval; the dimensions, as contrasted with those of a large Indian otter [*? Lutra nair*], are—

		Fossil.	Recent.
" Antero-posterior diameter of outer incisor	. . . . .	0·45	..
Transverse	" " " "	0·37	..
Antero-posterior	" " middle "	0·33	0·14
Transverse	" " " "	0·14	..
Antero-posterior	" " inner "	0·25	0·9
Transverse	" " " "	0·9	0·8

"In the younger animal to which [this] head belonged, the incisors are all present ;

¹ Figure 2 of plate Ia. of the memoir cited.

but in the older head [*Ibid.* fig 5] the middle incisors are not only wanting, but the alveoli are completely filled up and obliterated, there being nothing but a blank space between the outer incisors.”

“The canines of the upper jaw, like the lateral incisors, were proportionately large, and of great strength and massiveness. A section of the right one is got in the head, fig. 5, of a circular form. The dimensions are antero-posterior $5\frac{1}{2}$ lines, transverse ditto $4\frac{3}{4}$. In the head, fig. 2, both the canines had dropped out, and the two alveolar cavities are exposed, showing that the fang was comparatively short, and much dilated, evincing a resemblance in this respect to the canines of the *Seals*.”

In the specimen represented in figure 5 of plate XXVII of the present memoir, merely the alveoli of the canines and incisors remain: these shew that the middle incisors had not been shed during the life of the animal. It may be remarked that while in the living otters the antero-posterior diameter of the base of the canine is considerably less than the corresponding diameter of pm. 3; in the fossil form the former diameter is considerably the larger of the two. This is shown in the following measurements of the teeth of the skull figured in plate XXVII, fig. 5.

Length of <u>m. 1</u>	0.55
Width „ „	0.8
Length „ <u>pm. 4</u>	0.7
Width „ „	0.7
Length „ <u>pm. 3</u>	0.4
Width „ „	0.35
Ant. post. diam. of alveolus of canine	0.63
Transverse „ „	0.54

In *Lutra campani* the proportions of the canines and incisors are almost precisely the same as in the Siwalik form.

Summary.—The foregoing observations indicate that the so-called *Enhydriodon* was a lutrine animal considerably larger than any existing otter, with which, however, it agreed in the form of the skull. Moreover, in the young state the dentition agreed numerically with the condition in which it frequently exists in one of the living otters (*L. leptonyx*), although pm. 2 and one of the incisors were generally, or occasionally, shed as age advanced. The general form of the teeth makes a very near approach to that of the living otters; the main points of distinction being in the form of pm. 4, and in the relatively greater size of the canine and outer incisor. In the extinct *Lutra campani*, which was somewhat smaller than the Siwalik form, the proportionate size of the canine and incisors is approximately the same as in the latter; the form of pm. 4 is, however, intermediate between that of the latter and of existing species of *Lutra*, but perhaps nearer to the Siwalik fossil than to the living forms. In the whole of its dentition this form is, therefore, precisely intermediate between existing otters and the Siwalik form.¹ If *L. campani* be referred to the genus *Lutra*, the so-called *Enhydriodon* cannot be distinguished by any well-marked characters from that

¹ It should be observed that Dr. Falconer's memoir on *Enhydriodon* was not published at the date of Prof. Meneghini's memoir.

genus; while if *L. campani* be referred to *Enhydriodon*, there is equally no sufficient distinction between that genus and *Lutra*. If *L. campani* were referred to a new genus, and the genus *Enhydriodon* retained, the characters of these genera would be equally ill-defined, and unsatisfactory, and it seems, therefore, on the whole to be the preferable course to merge all the forms in the genus *Lutra*; *Enhydriodon*, if it be retained at all, not ranking higher than an ill-defined sub-genus, probably including *L. campani*. The variation in the form of the teeth of the genus *Lutra* as thus extended will not be greater than those existing in the genus *Ursus*.

Although the foregoing conclusions indicate a considerable range of variation in the form, number, and proportions of the dentition of the otters, they do not afford any indications of the genetic affinity of the group to the other carnivores. The suppression and early shedding of certain of the teeth in *Lutra sivalensis* indicates indeed that this form is even more highly specialized than most of the living otters, and that its nearest living ally is *L. leptonyx*: it cannot, therefore be in any sense regarded as an ancestral form of otter; an inference confirmed by the fact that it existed side by side with otters of the same type as the existing species. The most probable truly ancestral form of otter is, as already observed, the so-called *Lutricetus valetoni*,¹ of the miocene of the Continent, in which *m. 2* was developed as a minute tooth, while *m. 1* had not assumed the quadrangular form characteristic of the true otters: and in which the four premolars were placed behind the canine, indicating that the shortening of the muzzle so characteristic of the true otters had not then taken place. Even in *Lutricetus*, however, the upper carnassial had assumed the characteristic lutrine form, indicating that the ancestors of the group, connecting it with the purely land mustelines, must be sought in an earlier stage of the world's history.

Judging from the size of its teeth *Lutra sivalensis* must have attained to a considerably larger size than *Lutra sandbachii* (Gray)² of Demerara, the largest existing species of otter, the total length of which is given by Dr. Gray as 67 inches (head and body 43 in., tail 24 in.)

Alleged mandible.—On page 337 of the first volume of the "Palæontological Memoirs," there is published a manuscript note of Dr. Falconer's relating to the lower jaw of a carnivore from the Siwaliks, considered to belong to *Enhydriodon*. The specimen on which this note is founded is now in the British Museum, and has been referred by Mr. Bose to the genus *Canis*.³

Distribution.—The four skulls mentioned above are the only known remains of this species, and it is remarkable that all these specimens were obtained in the region of the typical Siwalik Hills, in the neighbourhood of the Ganges and Jumna valleys; and that not a single specimen belonging to this species has been obtained by Mr. Theobald, among the thousands of fossils collected by him from the Siwaliks of the Punjab.

¹ Gaudry, "Les Enchainements du Monde Animal, etc., Mammifères Tertiaires," fig. 290.

² "Catalogue of Carnivora, etc., in British Museum," figs. 16-17, pp. 116-7.

³ "Quar. Jour. Geol. Soc.," Vol. XXXVI., p. 136: *vide infra*.

FAMILY II.—*URSIDÆ*.

Extent of family.—In the first part of the "Enchainements du Monde Animal" Professor Gaudry¹ has shown that in spite of the great distinctions now separating the bears and the dogs,—distinctions of such importance as to be ranked of sub-ordinal value,—there are the strongest indications that in past times these distinctions did not exist, but that there was a complete passage from the one to the other. It is true that to a great extent the evidence for such a passage is afforded solely by the characters of the cheek-teeth, but there is also some evidence from other parts of the skeleton, and if it be remembered how different are the molar teeth of the bear and the dog, it is only reasonable to assume that if fossil forms indicate a complete passage in this respect from the one to the other, an analogous transition obtained in all other parts of the skeleton. In any case until the evidence of the dentition and such other part of the skeleton as is available be contradicted by other evidence the only logical course is to accept the former.

Since the publication of Professor Gaudry's work some highly important observations have been recorded by Dr. H. Filhol² in regard to three fossil Carnivora generally known as *Hyænaretos hemicyon*, *Dinocyon thenardi*, and *Cephalogale geoffroyi*, which, taken in conjunction with the evidence afforded by specimens described in the sequel of the present memoir, shows this relationship still more clearly. In regard to those three species, it is concluded that the first does not belong to the genus *Hyænaretos* (from which it is distinguished by the more dog-like form of the upper true molars), but is in all probability generically the same as the second, which in respect of such part of its dentition as is known agrees very closely with the dogs. In his description, led astray by an erroneous determination of Prof. Owen in regard to the lower carnassial of *Hyænaretos*, M. Filhol thought that *Dinocyon thenardi* had no affinity with that genus. It will, however, be shown below that the lower carnassials of both genera are constructed on the type of that of the dogs; and that the upper carnassial of the species which may in future be provisionally termed *Dinocyon hemicyon*³ is constructed on the type of that of *Hyænaretos*. It will also be shown that in respect of the upper true molar teeth

¹ "Mammifères Tertiaires," p. 211, *et. seq.*

² "Notes sur quelques Mammifères de l'Epoque Miocène (Observations relatives au Carnassiers signalé par Jourdan sous le nom de *Dinocyon Thenardi*)," Lyon, 1881, p. 43, pls. II.-III. ('Arch. d. Mus. d'Hist. Nat. d. Lyon,' vol. III.).

³ The genus *Hemicyon* was founded in 1851 by the late M. Ed. Lartet ("Notice sur la Colline de Sansan," p. 16), on the evidence of the upper molars of a dog-like carnivore from Sansan, considered to be allied to *Amphicyon*, and named *H. sansaniensis*. Subsequently two other specimens of the upper dentition of a carnivore considered to be probably the same as the *Hemicyon* of Lartet were described and figured by the late Prof. Gervais ("Zoologie et Paléontologie Françaises," 2nd ed., pl. LXXXI., figs. 8-9) under the name of *Hyænaretos hemicyon*. As it is pretty certain that these specimens do not belong to *Hyænaretos*, and as there is some doubt whether they are the same as Lartet's *Hemicyon*, it seems best to adopt the name *Dinocyon* for the genus to which they belong, although the former name has the priority. There is a slight difference between the two specimens figured by Gervais, but this may not be more than individual variation.

there is an almost complete transition from the true bears through *Hyænarctos* (which undoubtedly is essentially a bear) to *Dinocyon*, and so through *Cephalogale* to *Canis*. *Cephalogale* is classed by M. Filhol as closely related to the dogs, and also to *Dinocyon*, and it seems impossible to separate it from the modern *Canidae* by any character of more than generic value.

In another article in the same memoir,¹ M. Filhol has shown the intimate relationship exhibited by *Amphicyon* and *Cynodictis* to the dogs on the one hand, and to the bears on the other, and comes to the conclusion that these two genera probably took origin from a common stock; the former being not improbably the direct ancestor of the dogs, and the latter of the *Viverride*. It is at the same time suggested that the former, which is described as having the head of a dog and the limbs of a bear, may have been on the ancestral line of the bears, though there was not sufficient evidence to fully establish this point. Such evidence it is here submitted is afforded by the relationship of the dentition of *Hyænarctos* to *Dinocyon* and thus to *Cephalogale* and *Amphicyon*.

On this evidence it appears to the present writer, at all events for palæontological purposes, to be impracticable to continue to refer the bears and the dogs to separate families; as if this be done it is absolutely impossible to say with which of the two *Dinocyon* should be classed; since from its upper true molars it should be referred to the dogs, from its upper carnassial to the hyænarctoid bears, and from its lower carnassial to both.

For this provisional conjoint family it seems best to adopt the name *Ursidae*, making it to comprehend the two modern families of the *Ursidae* and the *Canidae*. In respect of other anatomical characters, it is already known that while the modern bears are plantigrade and pentadactylate, and the modern dogs digitigrade with only four anterior digits, there is good reason to believe that the extinct dog-like genera *Amphicyon* and *Cynodictis* were plantigrade and pentadactylate. The limb-bones of *Amphicyon* are described by M. Filhol in the memoir quoted as being precisely intermediate between those of the dogs and the bears. In their cranial characters Prof. Flower remarks² that the modern Cynoidea (*Canidae*) are intermediate between the modern Arctoidea (*Ursidae*, *Procyonidae*, and *Mustelidae*) and the *Eluroidea* (*Viverride*, *Hyænidae* and *Felidae*), and there is therefore no improbability that fossil forms should exhibit a complete transition from the canoid to the arctoid type of cranium.³ It unfortunately happens that in many of the transitional forms (e.g. *Hyænarctos*, and *Dinocyon*), the base of the cranium when known at all, is too imperfect for its characteristic points to be determined. In *Amphicyon*, however, M. Filhol has shown⁴ that there are certain characters of the base of the cranium (notably the minute size, or total absence, of a septum in the auditory bulla,⁵ and the presence

¹ *Op. cit.*, p. 70, "Observations relatives aux Chiens Actuels, et aux Carnassiers Fossiles s'en Rapprochant le plus."

² 'Pro. Zool. Soc.', 1869, p. 24.

³ The difficulty of distinguishing the *Canidae* from the *Viverride* will be mentioned below.

⁴ *Op. cit.*, pp. 84-5.

⁵ This septum is fully developed in the cats, absent in the bears, and half developed in the dogs.

of post-parietal and mastoid foramina), which are essentially arctoid. Such cranial evidence as there is, points, therefore, in the direction of the amalgamation of the arctoid and canoid cranial types. Should future discoveries show that the crania of the former genera strictly conform either to the arctoid or the canoid type, then the question of the re-establishment of the *Ursidae* and *Canidae* as distinct families (if families have not to be abolished altogether) may be taken into consideration. In the meantime the author sees no other course but to unite them.

It is at present impossible to give any definition of the family *Ursidae* as thus extended. The upper true molars are very generally two in number, but there may be either (occasionally) one (*Icticyon*), three (*Amphicyon*), or four (*Otocyon*): the lower true molars are generally three, but may be only two (*Cyon*) or four (*Otocyon*). The first upper true molar is invariably placed directly behind the carnassial; and in general the crowns of the true molars are well-developed: in the upper jaws they may vary in shape from oblong (*Ursus*), through a square (*Hyænarcos*), to triangular (*Canis*).

Although, as above said, it is logically impossible to draw any divisions of family value between the different genera of the *Ursidae* as thus extended, yet the convenience of having some division for working purposes among such a multitude of genera is so great, that it will be found advisable to rank the most bear-like genera under one arbitrary group, and the most dog-like genera under another. These two groups may respectively be termed *Ursinae* and *Canine*, and their most typical representatives will be the members of the modern families *Ursidae* and *Canidae*. The genus *Dinocyon* will be ranked under the first group, on account of at least one of its species having an upper carnassial of the *Hyænarcos* type, but it must be distinctly understood that its separation from the true dogs is a purely arbitrary one, it being connected with that group through *Cephalogale* just as intimately as it is with the bears through *Hyænarcos*.

GROUP A: *URSINÆ*.

Genera.—The existing bears are frequently divided into two or more genera, but for palæontological purposes it seems best to include all the forms under one genus. Adopting this course the number of genera which may be ranked in the present arbitrary group are probably five,¹ viz.: *Æluropus*, *Ursus*, *Arctotherium*² (*Arctoidotherium*), *Hyænarcos*, and *Dinocyon*. Of these the two first are alone existing, and the second is taken to include the whole of the true bears. The third is from the pleistocene of South America; while the fourth and fifth are from the pliocene and miocene of North America.

¹ *Leptarcus*, Leidy, of the tertiaries of N. America though classed by Prof. Leidy with the *Ursidae* ("Extinct Mammalian Fauna of Dakota and Nebraska," p. 70,) is allied to *Nasua*, and, therefore, belongs to the *Procyonidae*. *Metarctos* of Pikermi probably belongs to a distinct family, unless it indicates the unity of the *Ursidae* and *Viverridae*. *Arctocyon* (*Palæocyon*, Blain, not Lund), is the type of Prof. Cope's family *Arctocyonidae*, classed under his order *Cresodonta*.

² The history of this genus will be found below, under the head of *Hyænarcos*.

Dentition.—Regarding the cheek-teeth, and especially those of the upper jaw, it may be predicated of the entire group that the true molars are always two in number in the upper, and, with one exception, three in the lower jaw, but they vary very considerably both in the form of the outline of the crown, and in the relative degree of development of their four main cusps. In the upper jaw the outer pair of cusps, or lobes, are generally distinct, while the inner pair are very generally confluent into an antero-posterior ridge. In *Ursus* the crowns of the upper true molars are always longer than broad, while in *Hyænarcos* they are generally more or less nearly square, but in some forms they have a tendency to the obliteration of the internal angles of the crown, and thus pass imperceptibly into the transversely elongated molars of *Dinocyon* and the true dogs: this subject will be more fully noticed in the sequel.

Coming to the upper carnassial it will be found that, when known, this tooth is always of a more or less triangular form; and that (with the exception of *Æluropus*) its 'blade' or outer portion, normally consists of two main cusps or lobes: in some genera, however, (*Hyænarcos*) an anterior cusp, or talon, is developed, partaking more or less completely of the character of a third lobe: the inner, or tubercular portion, normally consists of a single cusp: the relationship of the upper carnassial of *Hyænarcos* to that of the dogs will be noticed below.

There is, however, another very important aspect in which the upper carnassial may be regarded. In classifying the dogs, Professor Huxley, as will be shown below, has arranged them according to the degree of development of the cheek-teeth in proportion to the size of the skull, and also to that of the upper carnassial to the true molars. With regard to the second relationship, it will be found that the present group may be arranged in two sections, accordingly as pm. 4 is smaller, or as large as, or larger than m. 1. The former section may be termed *meionocreodonts*, and the latter *megalocreodonts*, thus—

MEIONOCREODONTS

Ursus.

MEGALOCREODONTS

*Æluropus.**Arctotherium.**Hyænarcos.**Dinocyon.*

The following table gives the actual measurements of six species, viz.:—

	<i>Ursus</i> labiatus.	<i>Ursus</i> torquatus.	<i>Ursus</i> arctos.	<i>Æluropus.</i>	<i>Hyænarcos</i> sivalensis.	<i>Dinocyon</i> hemicyon.
Length of pm. 4	0.48 ..	0.48 ..	0.55 ..	1.0 ..	1.3 ..	(?) 1.2
„ „ m. 1	0.62 ..	0.78 ..	0.78 ..	0.88 ..	1.2 ..	0.85

It will be seen from these dimensions, that although the members of the genus *Ursus* do not form a completely progressive series, yet that the whole number of genera shows a general advance in the relative degree of development of the upper carnassial from the true bears to *Dinocyon*, in which, however, the length of that tooth can be only approximately given.

With regard to the true bears (*Ursus*) and their nearest allies (*Arctotherium*,

Hyenarctos), it may be remarked that while one of the megalocreodont forms (*Hyenarctos* d'Espagne¹) is of upper miocene age, none of the meionocreodont forms are known before the older pliocene. This is the more remarkable since the relative degree of the development of the carnassial to the hinder cheek-teeth (megalocreodontism) is indicative in some other groups of the Carnivora of high specialization, and therefore, the same may be presumed to hold good with regard to the bears. The explanation of this apparent anomaly is probably to be found in the supposition that the meionocreodont and megalocreodont bears at present known to us are diverging branches from a common stock, and that the common ancestors of the two are yet unknown. The very wide distribution in space of *Ursus* and *Hyenarctos*² also points to the conclusion that the common ancestor must have existed at a comparatively early stage of the tertiary period. The suppression of the first premolar in *Hyenarctos*, and the more essentially sectorial nature of the carnassial, all confirm the conclusion as to this group of the megalocreodont bears being the most specialized.

With regard to the disappearance of all the megalocreodont forms of the group (excepting the abnormal form *Æluropus* where the carnassial, though of relatively large size, is not of a markedly sectorial type) at the present day, it is not impossible that the more carnivorous nature of many of these forms, which is almost certainly indicated by the size and form of the carnassial, may have brought them into closer competition with the larger feline carnivores, and that not being such fleet animals they had not such good chances of obtaining their prey, and thus died out; while the meionocreodont forms, which, with the exception of the peculiarly situated polar bear, are not extensively carnivorous, have still remained, and hold their place among the modern felines, without entering into direct competition with them.

GENUS I.: *URSUS*, Linné.

INCLUDING *Davis*, *Euarctos*, *Helarctos*, *Melursus*, *Myrmarctos*, *Prochilus*, *Thalarctos*, *Thallasarctos*, *Tremarctos*.

Dentition, etc.—According to the arrangement adopted by Professor Flower in the catalogue of the osteological specimens in the Museum of the Royal College of Surgeons, the living bears are divided into two genera;—namely *Ursus*, and *Melursus*; the latter comprehending only the so-called sloth-bear, or aswail (*Melursus labiatus*) of India, and the former all the other species. One important point of distinction of the skull of the sloth-bear is the absence in the adult of the inner pair of upper incisors; while another is the relatively small size of the cheek-teeth. If, however, the cheek-teeth of an allied form were found in the fossil state apart from the palate it is improbable that they could be generically distinguished from the teeth of other bears, and it accordingly seems best for palæontological purposes to merge the genus *Melursus* with *Ursus*. It may be observed that the proper specific name of the sloth-

¹ Gervais, *op. cit.*, pl. LXXXI., fig. 2.

² *Vide infra*.

bear is undoubtedly *ursinus*, which was applied by Shaw in 1791, and if the generic term *Melursus* is employed, there can be no objection to using this specific name. If, however, the animal is referred to the genus *Ursus* the old specific name becomes practically ridiculous, and it then appears preferable to adopt Blainville's later specific name of *labiatus*.

With the exception of the last-named species in which, as already observed, the upper incisors are only two in number on each side, the typical adult dental formula of all the members of the genus *Ursus* is I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$. The whole of the premolars are relatively small; and this is especially the case with the first three, some or all of which very frequently fall out as age advances. The carnassial teeth have not the markedly sectorial character of the majority of the Carnivora; and the hinder molars have flat tuberculated crowns. There is a considerable amount of variation in the relative development of the cusps on the crowns of the cheek-teeth; these being most developed in the grizzly (*U. horribilis*) and polar bears (*U. maritimus*); and perhaps least so in the aswail (*U. labiatus*). This shows that no indication as to the carnivorous or frugivorous habits of the bears can be drawn from the characters of their molars, since while the polar bear is entirely carnivorous, the grizzly mainly subsists on a vegetable diet.

As the specimens to be described below only comprise a skull and part of the upper jaw it will suffice to notice on this occasion some of the more important distinctive characters of the upper molars, the specific characters of which will be noted in later paragraphs under the head of the respective species. For fuller details the reader is referred to Professor Busk's memoir on the "Quaternary Fauna of Gibraltar."¹

The upper carnassial is a triangular tooth, which, however, may still be divided into a 'blade' and 'tubercle': the relative position of the latter affording an important point of specific distinction: a minute cusp is sometimes found at the anterior edge of the main cusp of the tubercle, thus showing that the latter corresponds to the posterior inner cusp of the typical tooth. The first upper true molar is an oblong tooth, of a transitional character between the carnassial and the second true molar; the outer side of the crown carries two large cusps, corresponding to the 'blade' of the carnassial, and varying in their degree of development in the different species, and the inner side has a ridge, divided into two or three more or less distinctly defined cusps, the first and last corresponding to the inner cusps of the typical mammalian tooth: these may be termed the main cusps, and the middle one the accessory cusp. The second true molar is produced posteriorly into a talon, where it is generally more or less cut away on the outer side. The essential characters of the fore part of this tooth are very similar to those of the first true molar, but its cusps are less distinctly defined.

Distribution.—At the present day true bears are found over the greater part of

¹ 'Trans. Zool. Soc. Lon.' vol. X.

the world with the exception of Australasia, etc., and the greater part of Africa. There is, however, a considerable amount of evidence indicating that bears still exist in North Africa,¹ and they most certainly did so in the prehistoric period. No new fossil species of *Ursus*² have, it is believed, been found in America, and the earliest appearance of the genus in Europe seems to have been in the lower pliocene (stage of Montpelier).

Number of species.—Zoologists are still divided as to the number of species of existing bears, and more especially as to whether the black, brown, and grey bears of the palaearctic region should be classed under one, under three, or under more species.³ Since, however, in many of these cases the majority of these so-called species are defined solely or mainly on the characters of the pelage, their respective distinctions would manifestly be inapplicable for palæontological purposes. Accordingly for these purposes, without going into the question of the validity of these so-called species, the number of species of *Ursus* may be reduced to a comparatively small number. The following list comprises the best known of these species, with their more important synonymy. Under such of the species as the author has had an opportunity of examining, or of which there are good figures, the more important characters of the upper dentition, and the shape of the palate, are briefly noticed. The list does not include the Indian fossil species described in the sequel. Doubtful, or insufficiently described species are indicated by an asterisk:—

1. *URSUS AMERICANUS*,⁴ Pallas. Recent, N. America.

- | | |
|--|--|
| (?) <i>U. cinnamomeus</i> . Baird. | (?) <i>Euarctos cinnamomeus</i> . Gray. |
| <i>U. gularis</i> . ⁵ Geof. | <i>Euarctos americanus</i> . Gray. |
| (?) <i>U. luteolus</i> . H. Smith. | <i>Helarctos</i> (?) <i>nasutus</i> . Gray.* |
| <i>U. nasutus</i> . ⁶ Scl. | |

In this species the cheek-teeth are of moderate size and normal; the tubercle of the carnassial is generally well developed; the premolars are separated from one another and the palate is flat and narrow.

2. *URSUS ARCTOS*, Lin. Recent and pleistocene, palaearctic.

- | | |
|--|---|
| <i>U. cadavarinus</i> . Evsm. | (? var.) <i>U. leuconyx</i> . Sevtz. |
| <i>U. collaris</i> . F. Cuv. | <i>U. longirostris</i> . Schinz. |
| (?) <i>U. eversmanni</i> . Gray. | <i>U. niger</i> . Goldf. |
| <i>U. falcularis</i> . Reichenb. | <i>U. norvegicus</i> . F. Cuv. |
| <i>U. formicarius</i> . Evsm. | (? var.) <i>U. pruinosus</i> . Blyth. |
| <i>U. fuscus</i> . Alb. Mag. | <i>U. pyrenaicus</i> . F. Cuv. |
| var. a. <i>U. isabellinus</i> . Horsf. | var. b. <i>U. syriacus</i> . Hemp. and Ehr. |
| (?) <i>U. lasiotus</i> . Gray. | (?) <i>Myrmarcos eversmanni</i> . Gray. |

A moderately sized species with the cheek-teeth relatively large; m. 2 is as long as the two preceding teeth; pm. 4 relatively large, with the main inner cusp very large, and placed posteriorly, and a minute trace of the anterior cusp. The

¹ See Busk, *op. cit.*, pp. 73-4.

² *Ursus brasiliensis* and *U. bonariensis* are probably *Areotherium*.

³ See L. J. Fitzinger, "Untersuchungen über die Artberechtigung einiger seither mit dem gemeinen Bären (*Ursus arctos*) vereinigt gewesenen Formen," (Sitz. d. k. Akad. Wissensch., vol. LXXXIV., pt. I., 1881.

⁴ Blainville, "Ostéographie" Genus *Ursus*, pl. XII.

⁵ 'Pro. Zool. Soc. Lon.', 1871, p. 232.

⁶ *Ibid.*

palate is quite flat, and the early premolars are not crowded together: pm.1 is smaller than pm.3.

3. *URSUS ARVERNENSIS*.¹ Cr. and Job. Pliocene and pleistocene, Europe.

U. minimus, Dev. and Bouil.

U. minutus, Gerv.

A smaller species than the last; the cheek-teeth are relatively large; m.1 shorter than the two preceding teeth: pm.4 long, with no distinct inner tubercle: earlier premolars separate, and the palate flat.

*4. *URSUS CROWTHERI*, Schinz. Recent, N. Africa.

Specific distinctness very uncertain.

5. *URSUS ETRUSCUS*.² Cuv. Up. pliocene, Europe.

Apparently very imperfectly known: the specimens figured by De Blainville comprise part of the maxilla and mandible, indicating a large species; pm.4 much elongated, with medium tubercle: early premolars separate.

*6. *URSUS FAIDHERBIANUS*, Bourg. Prehistoric (?), N. Africa.

Very insufficiently determined.

? = *U. arctos* or *U. horribilis*.

7. *URSUS HORRIBILIS*, Ord. Recent, N. America; pleistocene, Europe.

U. bourguignati, Lart.

U. horridus, Baird.

U. cinereus, Gray.

(?) *U. piscator*, Gray.

U. ferox, Rich.

U. priscus, Cuv.

U. „ fossilis, Busk.

U. richardsoni, Baird.

U. fossilis, Goldf.

Danis cinereus, Gray.

A gigantic species with the cheek-teeth very large, and with strongly developed cusps: m.2 is but slightly contracted posteriorly: the inner tubercle of pm.4 is very large; the premolars are separate, and the palate flat.

8. *URSUS JAPONICUS*, Scl.³ Recent, Japan.

A small species, about two-thirds the size of *U. torquatus*, said to be closely allied to *U. americanus*, from which it is distinguished by its smaller size and the total absence of the inner tubercle to pm.4.⁴

9. *URSUS LABIATUS*, Blain. Recent, Peninsular India, Ceylon, and (?) south of Assam.

Bradypus ursinus, Shaw.

Melursus ursinus, Flower.

Melursus lybicus, Meyer.

Prochilus labiatus, Ill.

Ursus inornatus, Fuchs.

A moderate sized species, in which the cheek-teeth are relatively very small: in m.1 the cusps, though small, are distinct, but in m.2 they cannot be recognized:

¹ Blainville, "Ostéographie" Genus *Ursus*, pls. XIII.-XIV.

² *Ibid*, XIV.

³ 'Pro. Zool. Soc.', 1862, p. 261—1880, p. 442.

⁴ In Dr. Günther's note on this species ('P.Z.S.', 1880, p. 442) it is stated that the upper carnassial (pm.4) wants the inner cusp (tubercle) so well developed in *U. ornatus* and *U. americanus*: figures of the carnassial of the latter and of *U. japonicus* are given, but the numbers have been misplaced; the tooth assigned to *U. japonicus* (fig. 1) having this tubercle, while it is wanting in the tooth assigned to *U. americanus*.

pm. 4 has a large inner cusp: the length of m. 2 is very much less than that of the two preceding teeth: earlier premolars widely separate. The palate is wide, and posteriorly somewhat concave, but has a remarkable transverse elevation immediately behind the canines, in advance of which it slopes upwards towards the incisors.

- *10. *URSUS LARTETIANUS*, Bourg. Prehistoric (?), North Africa.

Very doubtfully distinct.

- *11. *URSUS LETOURNEUXIANUS*, Bourg. Prehistoric (?), N. Africa.

Very doubtfully distinct.

12. *URSUS MALAYANUS*,¹ Raffl. Recent, Malay Peninsula, and Burma to Arakan.

Helarctos eurystylus. Horsf. *H. malayanus*. Horsf. *Prochilus malayanus*. Gray.

A small species with m. 2 very much shorter than the two preceding teeth: inner tubercle of pm. 4 moderate: a distinct cingulum to pm. 4 and the true molars: earlier premolars crowded together: palate flat and unusually broad.

13. *URSUS MARITIMUS*,² Desm. Recent, North Polar regions.

U. albus. Bris. *U. polaris*. Shaw.

U. marinus. Pal. *Thalarctos maritimus*. Gray. *Thallasarctos maritimus*. Gray.

A large species with the cheek-teeth proportionately small, but with very strongly developed cusps; m. 1 obliquely truncated on the outer side posteriorly, and much shorter than the two preceding teeth: inner tubercle of pm. 4 very small: earlier premolars separate: palate concave.

14. *URSUS ORNATUS*,³ F. Cuv. Recent, S. America, and (?) Formosa.

(?) *U. formosanus*.⁴ Swinh. *Helarctos ornatus*. Gray. *Tremarctos ornatus* Gerv.

A small species, with m. 2 much shorter than the two preceding teeth: the inner tubercle of pm. 4 distinct, and placed more anteriorly than usual: premolars crowded together: palate somewhat concave.

- *15. *URSUS ROUVIERI*, Bourg. Prehistoric (?), N. Africa.

Very doubtfully distinct.

16. *URSUS SPELÆUS*, Rosenmüll. Pleistocene, Europe.

The largest known bear; the cheek teeth are relatively large; there is a large inner tubercle to pm. 4; the earlier premolars are separate; and the palate flat.

17. *URSUS TORQUATUS*,⁵ Wag. Recent, Persia, Baluchistán, Sind, Forest regions of Himalaya, (?) South Assam, and S. China.

(? var.) *U. gedrosianus*.⁶ Blanf. *Helarctos tibetanus*. Gray.

U. tibetanus. F. Cuv.

¹ Blainville, "Ostéographie," Genus Ursus, pl. XII.

² *Ibid.*

³ *Ibid.*

⁴ According to Dr. Gray ("Cat. of Carnivora, etc., in Brit. Mus.," p. 226), *U. formosanus*, Swinh.=*U. tibetanus*; but according to Dr. Günther ('Pro. Zool. Soc.,' 1880, p. 443) the bears collected by Mr. Swinhoe in Formosa agree in their dentition with *U. ornatus*.

⁵ The author follows Mr. W. T. Blanford ('Jour. Asiat. Soc. Bengal,' 1877, p. 320) in adopting the specific name *torquatus* in place of the highly objectionable name *tibetanus*.

⁶ 'Pro. Asiat. Soc. Bengal,' Jan., 1879, p. 4. It is there stated that there is some reason to think that *U. torquatus* may range into Eastern Siberia.

A species attaining a considerable size: m. 2 slightly shorter than the length of the two preceding teeth: pm. 4 relatively small, with the inner tubercle placed somewhat anteriorly: the earlier premolars approximated, pm. 1 larger than either pm. 2 or pm. 3: palate very slightly concave.

It may be added that the following among other species originally referred to the genus *Ursus* really belong to other genera; viz.:

<i>U. brasiliensis.</i>	Lund.	}	<i>Arctotherium.</i>
<i>U. bonariensis.</i>	Gerv.		
<i>U. cancrivorus.</i>	Cuv.	}	<i>Procyon.</i>
<i>U. lotor.</i>	Lin.		
<i>U. caudivolutus.</i>	Cuv.	=	<i>Cercoleptes.</i>
<i>U. melanoleucus.</i>	Gerv.	=	<i>Æluropus.</i>

Microdont and macrodont forms.—Following a modification of the system adopted by Professor Huxley in his classification of the dogs, whereby that group is divided into microdont and macrodont forms according to the proportionate size of the cheek-teeth to that of the skull, it will be found that a similar relation holds good in the genus *Ursus*. In this genus it has been found best to take the length of m. 1 as unity, and to see how many times that length is contained in the width of the palate at the same tooth. This relation is given in the following table, viz.:—

Table showing proportionate width of palatal aspect of Ursus at m. 1, that tooth being taken as unity.

<i>Ursus horribilis</i>	3.1	} macrodonta.
„ <i>americanus</i>	. . . . .	3.3
„ <i>arctos</i>	. . . . .	3.3—4
„ <i>torquatus</i>	. . . . .	3.3—5
„ <i>arvernensis</i>	. . . . .	3.4
„ <i>spelæus</i>	. . . . .	3.5
„ <i>ornatus</i>	3.6	} microdonta.
„ <i>malayanus</i>	. . . . .	3.9
„ <i>maritimus</i>	. . . . .	4.3
„ <i>labiatus</i>	4.6	

It is believed that all the other forms given in the foregoing list of species would belong to the macrodont division. It is noteworthy that the two microdont forms are frequently referred to distinct sub-genera or genera (*Thalassarctos* and *Melursus*).

Species I. *URSUS THEOBALDI*, n. sp., *nobilis*.

History.—The cranium on which this species is founded was briefly referred to on page 104 of the IXth. volume of the “Records” as belonging to a new species of *Ursus*.

Cranium.—The above-mentioned cranium, figured of half the natural size in plate XXVIII., figures 1 and 2 of the present memoir, was obtained by Mr. Theobald in 1875 from the Sivaliks of the Kangra district. The specimen, which comprehends the nearly entire cranium, has been much damaged by rolling, especially on the upper surface; and from this cause the crowns of the whole of the teeth have been

battered off. The palatal surface was, however, still buried in matrix, and careful chiselling has revealed this surface in a more perfect condition: on the left side the position of the 'fangs' of the canine and cheek-teeth has been made visible by cutting and polishing the alveolar ridge. Both zygomatic arches have been broken away, but the glenoid cavity (gl.) remains on the left side: the specimen is not sufficiently perfect to indicate the position of the basi-cranial foramina, or the exact limits of the component bones of this part. Bad as the condition of the specimen undoubtedly is, the palate fortunately affords ample characters for indicating its specific distinctness from all described bears; many of these characters are, however, somewhat difficult to clearly portray in the figure.

In the first place an inspection of the figures will at once show that the specimen undoubtedly belongs to the genus *Ursus*. The generic determination being accepted, the most important specific characters are to be found in the form of the palate, and in the size and position of the cheek-teeth. The palate is deeply concave between the molar series, and its hinder free border (pal.) extends very far back behind the last molar (m.2): at the anterior border of the latter tooth the median line of the palate is elevated upwards of one inch above the level of the molar alveoli. Anteriorly the vaulting or concavity of the palate gradually diminishes till at the hinder border of the canines there is a distinct transverse ridge, only slightly above the level of the alveolar ridges: in advance of this the palate slopes upwards and forwards towards the incisors, the free extremity having been broken off in the specimen: posteriorly to the ridge the slope of the palate is upwards and backwards. The general form of the palate, and more especially of the transverse ridge behind the canines, and the consequent opposite direction of the slope of the two surfaces before and behind this ridge, is nearest to the form of the palate of the living *Ursus labiatus*, and *totally distinct from the palates of all other species of the genus*, in which the anterior portion of the palate is either horizontal (*U. arctos*, *U. torquatus*), or slopes upwards and backwards (*U. maritimus*). In the fossil, however, the vaulting of the hinder part of the palate is very much greater than in *U. labiatus*; the surface of the hinder part of the palate in the latter not being elevated more than a quarter-of-an-inch above the molar alveoli. In both skulls the free posterior border of the palate (pal.) is produced far behind the molar series: this extension being mainly due to the circumstance that the last molar (m.2) does not extend (as it does in all other bears, though least so in the polar bear,) behind the root of the zygoma; but partly to the proportionately great development of the hinder part of the palate itself. This character is most developed in the fossil; and the vaulting of the post-molar portion of the palate in the latter causes this part of the skull to be narrower than in the recent form.

Turning to the dentition, the polished alveolar ridge of the left side of the specimen (fig. 2) exhibits transverse sections of the bases of the crowns of all the cheek-teeth. The three first premolars are separated from one another by distinct

intervals, but the third (pm.3) should have been placed nearer to the succeeding tooth than is the case in the figure. The sections of pm.4, m.1, and m.2 are distinctly shown in the figure, but they are seen to be imperfect on the inner side. In order to determine the width of these alveoli the opposite alveolar ridge has also been ground down since the figure was drawn, by which means there has been obtained a perfect section of the alveolus of m.2.

In the following table the dimensions of the palatal aspect and the alveoli of the cheek-teeth are compared with the corresponding dimensions of four living species of bear, from the author's own collection.¹ The skulls of *U. arctos* (var. *isabellinus*), and *U. torquatus* are small specimens:—

	U. labiatus.	Specimen.	U. maritimus.	U. arctos.	U. torquatus.
Width of palate at m. 1	2·89	32° ..	2·83 ..	2·68 ..	2·55 ..
Prolongation of palate behind m. 2	1·95 ..	2·41 ..	1·34 ..	0·54 ..	0·94 ..
Length of whole palatal aspect	10·9 ..	12·6 ..	12·4 ..	..	8·9 ..
" " alveoli of last 3 cheek-teeth	1·83 ..	2·22 ..	2·25 ..	2·44 ..	2·25 ..
Interval between canine and pm. 4	1·27 ..	1·62 ..	1·44 ..	..	0·51 ..
Length of alveolus of pm. 4	0·41 ..	0·51 ..	0·47 ..	0·48 ..	0·44 ..
Width " " " " (posteriorly)	0·31 ..	0·3 ..	0·28 ..	0·44 ..	0·3 ..
Length " " " m. 1	0·55 ..	0·62 ..	0·66 ..	0·67 ..	0·62 ..
Width " " " " "	0·39 ..	..	0·4 ..	0·62 ..	0·58 ..
Length " " " " 2	0·75 ..	0·89 ..	0·91 ..	1·08 ..	1·02 ..
Width " " " " (middle)	0·26 ..	0·51 ..	0·48 ..	0·65 ..	0·6 ..

From these dimensions the length of m.1 may be very closely estimated, and taking this as unity the width of the palate w.1 will be about 4.59; or proportionately very similar to the condition prevailing in *U. labiatus*, and thereby indicating that the specimen is related to the microdont division of the genus. The dimensions of the alveoli of the cheek-teeth indicate, however, that the other teeth were proportionately considerably more developed than in *U. labiatus*; and more nearly resembled in this respect *U. maritimus*. Taking the three last teeth separately, as indicated by their alveoli, the carnassial (pm.4) must have been longer and narrower than the corresponding tooth of *U. labiatus*: its hinder root (as can be seen in the figure) is sub-cylindrical in section, and shows no tendency to a bilateral division; it is in fact very similar to the same alveolus in *U. torquatus*, and quite different from that of *U. arctos*: from which it may be inferred that the carnassial of the fossil had but a very small inner tubercle, which was placed in the middle of the tooth, as in *U. torquatus*. It may be added that in the polar bear the two roots of pm.4 are usually conjoint. The roots of m.1 are not well displayed in the fossil, but as far as the alveoli show, they must have been proportionately stouter than in *U. labiatus*. In m.2, however, the roots are well preserved, and show (as is seen on the left side of the figure) that they were different from the aborted condition in which they exist in

¹ As it was necessary for this comparison to extract the teeth of the specimens examined, it is obvious that it could not be applied to specimens in the public collections.

U. labiatus. On the right side of the specimen (*ground down since the figure was made*) the alveolus of this tooth shows that it bore two stout fangs on both the outer and the inner sides, the hinder one of the latter pair being elongated posteriorly, and at the base of the crown united with the anterior roots of the same side: the union of these roots did not, however, extend so deep down as in *U. torquatus* and *U. aretos*. The dimensions of the whole alveolus of this tooth show that it must have attained dimensions proportionately very similar to those of the corresponding tooth of *U. maritimus*, and must have been relatively much narrower than in typical macrodont bears like *U. aretos* and *U. torquatus*. The early premolars correspond precisely with those of *U. labiatus*.

These comparisons indicate that the cheek-teeth of the skull under consideration, though agreeing in position with those of *U. labiatus*, must have been intermediate in their proportionate size between the latter and the cheek-teeth of typical species of bear; and that in this respect they approached nearest to the teeth of *U. maritimus*. This resemblance is not, however, in all probability indicative of any direct affinity with that species, since the characters of the palate, and the position of the early premolars all point to strong affinity with *U. labiatus*. Since the premaxillæ of the specimen have been broken away, it is impossible to determine whether the middle pair of incisors was absent, as in the last-named species. That portion of the premaxillæ still remaining shows, however, that in the fossil, as in *U. labiatus*, there must have been a considerable interval between the canine and the outer incisor, which in other bears are approximated: the outer incisor was relatively small, as in *U. labiatus*, and quite different from the large size which this tooth attains in *U. aretos*.

As far as the battered condition of the specimen under consideration admits of comparison, the other most important points in which it differs from the skull of *U. labiatus* are, firstly, the form of the glenoid cavity (gl.), which is more produced transversely, and has its anterior (preglenoid) process more distinctly developed; probably indicating greater power of jaw, and closely resembling the corresponding part in the polar bear; and, secondly, the vaulting, in place of the flatness, of the sphenoidal region; the latter character being probably correlated with the excessive vaulting of the palate. On its superior aspect the fossil skull appears to have the profile of the cranial box much less vaulted than in *U. labiatus*; and the nasal profile less concave: the muzzle appears also broader and flatter: the orbits of the two forms agree, however, in having their antero-posterior diameter longer than the vertical one, and in this respect differ from other bears.

Finally it may be said that while the skull under consideration comes nearest to that of *U. labiatus*, of all sufficiently described species of bears, given in the above list,¹ yet that the points of difference between the two are so strongly marked that there cannot be the slightest doubt but that they are specifically distinct. Under

¹ Its distinctness from *U. nanadicens* of Falconer and Cautley will be indicated in the sequel.

these circumstances it is proposed to distinguish the fossil form under the name of *Ursus theobaldi*, in honour of Mr. W. Theobald, late of the Geological Survey, to whose untiring labours is due the addition of this (and so many other) species to the Siwalik fauna.

Relation to U. labiatus.—The relationship of *Ursus theobaldi* to *U. labiatus*, which at the present day stands completely isolated from all other bears, is a matter of extreme interest, and one which seems to throw a considerable amount of light on the origin of the latter. In the first place the resemblance between the skulls of the two forms is so great, and their distinctions from the skulls of other bears are so well marked, that there can scarcely be any doubt that the fossil must have been on the direct line of ancestry of the living species. Assuming this to be the case, and seeing that the cheek-teeth of the former are considerably more developed than those of the latter (attaining a development about equivalent to that existing in the polar bear), it follows that the aborted dentition of *U. labiatus* is a character which the *stürps* has acquired comparatively recently, and is not, as might have been supposed, a retention of an ancestral feebly developed dentition. The cause of the aborted dentition of the aswail (*U. labiatus*) may probably be sought in the nature of its food, which, according to the late Dr. Jerdon,¹ consists of the larvæ of a gigantic longicorn beetle, of black ants, termites, beetles, fruits (particularly the seeds of *Cassia fistula*,² and the date-palm), honey, and the fleshy flowers of the mohwa tree (*Bassia latifolia*). According to Prof. V. Ball³ this bear subsists on "the fruits of several species of fig, the wild plum, or jujube (*Zizyphus jujuba*), the flowers of the mhowa, sugar-cane, &c., it also is fond of termites, or white ants, the larvæ of several insects and honey." The larvæ and ants are sucked out from their holes, after the ground has been opened by the powerful claws of the bears. In contrast to this, Dr. Jerdon's account of the food of the other Indian bears may be cited. Of the snow bear (*U. arctos*, var. *isabellinus*) he observes they feed in autumn "on various fruit, seeds, acorns, hips of rose-bushes, &c., often coming close to villages to plunder apples, walnuts, apricots, buck-wheat, &c. Their usual food in spring and summer is grass and roots." The black bear (*U. torquatus* [*tibetanus*]) is stated to live chiefly on "fruits and roots, apricots, walnuts, apples, currants, &c., also on various grains, barley, Indian corn, buck-wheat, &c.; and in winter chiefly feeds on various acorns."

It will be seen from these accounts that the food of the aswail contains none of the hard substances on which the other bears subsist, and, indeed, consists almost entirely of succulent substances which require little or no mastication. The nature of its food is, therefore, quite sufficient to account for the aborted molar dentition of this remarkable, and, in this respect, highly specialized form.

1 "The Mammals of India," ed. 1874, pp. 72-4.

2 The fruit of this species consists of long black pods containing numerous seeds buried in a fleshy pulp.

3 "Jungle Life in India," London, 1880, p. 660.

Seeing that the most remarkable character of the aswal is its peculiarly aborted molar dentition, and that in its probable ancestor *U. theobaldi* this character was not nearly so well marked, it is pretty evident that the latter species forms a well-marked connecting link between the aswal and other bears, and renders it extremely problematical whether the sub-genus *Melursus* can henceforth be logically maintained.

Distribution.—As the specimen described above is the only one yet known that can be referred to the present species, nothing further can be added regarding its distribution.

Species 2. *URSUS NAMADICUS*. Falc. and Caut.

History.—The name of *Ursus namadicus* does not seem ever to have been published in Dr. Falconer's lifetime, but appears for the first time in the "Palæontological Memoirs,"¹ where it is applied to two specimens in the British Museum figured in plate O of the supplement to the "Fauna Antiqua Sivalensis"; the description of the figures having probably been compiled from Dr. Falconer's manuscript. In the "Palæontological Memoirs"² one of the specimens so designated is refigured with the same designation.

Maxilla.—In figure 3 of plate XXVIII. of the present volume there is represented a part of the right maxilla of a bear from the Narbada deposits, which is the type specimen on which the present species is founded. This specimen is now in the British Museum (No. 39,720); and is also figured in plate O, fig. 8 of the "Fauna Antiqua Sivalensis"; and (of one half the natural size) in plate XXVI., figure 5, of the first volume of the "Palæontological Memoirs." It is described in the latter work as a "portion of upper jaw with four molars of a smaller [in reference to *Hyænarctos*] species of Bear, from the Nerbudda" The specimen shows part of the palate, and in its present condition has only three teeth (pm. 4; m. 1; m. 2); but in the figures above quoted there is also a relatively large pm. 3 in advance of the carnassial, which has been subsequently broken away. It will be seen from the figure that the specimen undoubtedly belongs to a true *Ursus*.

In the first place the portion of the palate still attached to the specimen shows that this part is perfectly flat, while the cheek-teeth are relatively as large as those of typical macrodont bears. These characters show that the specimen can have no affinity with *U. labiatus*. The same characters, and the large size of pm. 4, also show that the specimen does not approach *U. maritimus*. The presence of a large tubercle to pm. 4, the great proportionate width of the true molars, and the flatness of the palate indicate moreover that the specimen has no affinity with *U. theobaldi*; and comparisons may accordingly be confined to the typical macrodont forms.

The teeth of the Narbada specimen are in an early stage of detrition; the last molar is considerably damaged, and m. 1 has lost a small portion of its postero-external angle. The carnassial (pm. 4) is relatively large, with a well-developed

¹ Vol. I., p. 552.

² *Ibid.*, pl. XXVI., fig. 5.

inner tubercle, placed opposite the hinder lobe of the blade; of which the foremost lobe carries a distinct cingulum. The first true molar (m.1) is a nearly square-crowned tooth; and m.2 is relatively short. In the following table the dimensions of the teeth of the specimen are compared with those of the teeth of *U. torquatus*, *U. arctos* (var. *isabellinus*), and *U. horribilis*: the dimensions of the first are taken from a small skull belonging to the author: those of the second from (a) a small skull belonging to the author, and (b) from Mr. Busk's tables¹; those of the third are from the same.

	<i>U. namaticus</i> .	<i>U. torquatus</i> .	<i>U. arctos</i> .		<i>U. horribilis</i> .
			a.	b.	
Length of 3 last cheek-teeth	2.44	2.31	2.53		
„ „ pm. 4	0.65	0.47	0.58	0.65	0.67
Width „ „ „	0.53	0.32	0.46	0.45	0.5
Length „ m. 1	0.74	0.78	0.75	0.9	0.9
Width „ „ „	0.71	0.62	0.59	0.6	0.7
Length „ „ „	1.06	1.09	1.3	1.44	1.5

These dimensions show that the fossil differs from *U. torquatus* by the greater relative size of pm.4, and the larger development of its tubercle; and also by the greater proportionate width of m.1: the two agree in the relative shortness of m.2. From *U. arctos* the specimen is readily distinguished by the proportionate shortness of m.2; the carnassials of the two are more equal in size, but that of the fossil is somewhat wider, and has its tubercle placed still further back. From *U. horribilis* the fossil is distinguished by the relatively greater width of m.1; by the shortness of m.2; and by the tubercle of pm.4 being placed entirely behind the division between the two lobes of the blade, instead of in the middle of the same.

Ursus americanus is distinguished by m.1 being relatively longer and narrower (0.73x0.54), and by the tubercle of pm.4 being placed in the middle of the tooth. *U. arvernensis* is also distinguished by the more elongated form of m.1, and still more completely by the form of pm.4, in which the tubercle is small and placed in the middle: it is also distinguished by the presence of a distinct interval between pm.3 and pm.4, which teeth are seen from the original figure to have been closely approximated in the fossil. *U. etruscus* is distinguished by the elongated form of pm.4 (0.72x0.5); by the larger size of m.1 (0.98x0.81); and the distinct interval between pm.3 and pm.4. *U. japonicus* is at once distinguished by its smaller size, and the complete absence of any tubercle to pm.4. In *U. malayanus* the whole molar dentition is absolutely smaller than in the fossil, the length of the three last teeth being only 1.9: it is also readily distinguished by the smaller extent of the backward prolongation of m.2, this tooth being but slightly larger than m.1: the following measurements show these differences:—

¹ 'Trans. Zool. Soc.,' vol. X., pl. XXVII.

	<i>U. malayanus.</i>	<i>U. namadicus.</i>
Length of last three cheek-teeth	1.9	2.44
„ „ <u>pm.4</u> . . . . .	.046	0.65
Dimensions of <u>m.1</u>	0.66×0.59 ..	0.74×0.71
Length of <u>m.2</u>	0.8	1.06

The living species is also distinguished by the minute size of pm.3, and the relatively small size of pm.4, and by the tubercle of this tooth being placed in the middle of the inner side. The two nearly agree, however, in the proportionate width of m.1.

In *U. ornatus* the whole molar dentition is much smaller; m.2 is relatively much narrower, as is shown by the following measurements, *viz.* :—

Length of last three cheek-teeth	1.75
„ „ <u>pm.4</u>	0.4
Dimensions of <u>m.1</u>	0.65×0.46
Length of <u>m.2</u>	0.74

The tubercle of pm.4 is also placed in the middle of the inner side.

Ursus spelæus is sufficiently distinguished from the fossil by its vastly superior size, and the greater complexity of the surface of the crowns of the molars.

The other species mentioned in the foregoing list are not sufficiently well known to admit of comparison with the fossil, and unless it should be the same as any of these, it seems that the latter is entitled to rank as a distinct species, for which the name of *U. namadicus* may be retained. As far as can be judged from the extremely imperfect remains at present available, that species seems on the whole to have approached nearest to *Ursus malayanus*, but is distinguished by its superior size, and the form and relative dimensions of pm.3, pm.4, and m.2. It is impossible to say at present whether or no the one form may be regarded as on the direct line of descent of the other.

Canine tooth.—In the Indian Museum there is the canine tooth of a bear obtained by Mr. Hacket, of the Geological Survey, from the Narbada beds, which may possibly belong to the present species.

Tibia.—In figures 3, 3a, of plate XXIX. of the present memoir¹ there are given two views of the left tibia of a bear from the Narbada beds, presented by Mr. C. Frazer to the British Museum (No. 39,729). The specimen is drawn of one-third the natural size, and is viewed in figure 3 from the anterior, and in figure 3a from the distal aspect. In point of size the specimen might well belong to the present species. The collection of recent osteology in the British Museum being at the time of writing this passage inaccessible, it has not been found possible to compare the fossil with the tibias of recent bears.

Distribution.—All the remains which can at present be assigned to *Ursus namadicus* have been obtained from the pleistocene Narbada beds.

GENUS II: HYÆNARCTOS, Falc. and Caut.

Syn. *Agriotherium*, Wag. *Amphiarctos*, *Sivalarctos*, Blain.

History.—In 1836 there appeared in the XIXth volume of the "Asiatic Researches" a paper by Messrs. Falconer and Cautley, describing, without illustrations, the cranium and mandible of a large bear-like animal from the Sivaliks, under the name of *Ursus sivalensis*. In the following year Herr Wagner¹ proposed that this form should be referred to a new genus under the name of *Agriotherium*. Five years later (1841) M. de Blainville, apparently ignoring Wagner's name, also came to the conclusion that the Sivalik animal was generically distinct from *Ursus*, and proposed for it in one place² the name *Sivalarctos*, and in another³ *Amphiarctos*. In 1842 Dr. Falconer wrote a notice, which, however, was never published till 1868, after his death,⁴ in which he reiterated his original conclusion that the animal in question was not generically distinct from *Ursus*. It appears, however, that soon after that note was written Dr. Falconer must have changed his opinion, since Prof. Owen, in describing this form in his "Odontography,"⁵ published from 1840 to 1845, states that "the term *Hyænarctos sivalensis* has, however, been provisionally assigned by its Discoverers to the extinct species, which, from the modification of its molars, ought to be regarded as subgenerically distinct from the true *Ursi*." The original specimens were figured by Prof. Owen (pl. CXXXI.) under the above-mentioned name. The present writer has been unable to discover the authority for Professor Owen's statement; and it appears, indeed, that the passage quoted from his work is the one in which the name *Hyænarctos* first appears. In plate O of the supplemental plates of the "Fauna Antiqua Sivalensis," stated by Dr. Murchison⁶ to have been executed about 1848, the species is designated *Ursus (Hyænarctos) sivalensis*. In a manuscript note of Dr. Falconer's written in 1857⁷ the specimen is alluded to simply as *Hyænarctos*. In 1859 Prof. Gervais⁸ described under the name of *Hyænarctos* certain species belonging to the same genus as the Sivalik form, observing "Le nom de *Hyænarctos* n'est pas le seul qui ait été donné au genre de grands Carnivores ursiformes, qui a pour type l'*Ursus sivalensis*; il n'est pas davantage le plus ancien. . . . Toutefois le nom *Hyænarctos* a prévalu." In 1877 Professor Flower, in describing⁹ some molar teeth, also adopts the same generic name.

It thus appears that Wagner's name of *Agriotherium* clearly has the priority

¹ 'Münchn. gelerten Anzeigen,' 1837.² 'Compt. Rend.,' 1841, p. 165.³ 'Ostéographie,' vol. II., pp. 96-113.⁴ 'Palæontological Memoirs,' vol. I., p. 328.⁵ p. 505.⁶ 'Palæontological Memoirs,' vol. I., p. 321.⁷ *Ibid*, p. 329.⁸ 'Zoologie et Paléontologie Françaises,' 2nd ed., p. 208.⁹ 'Quar. Jour. Geol. Soc.,' vol. XXXI., p. 534.

over all the other names.¹ The name *Hyænarcos* has, however, acquired such a general acceptance that it seems best that it should be retained, although it is a somewhat misleading one.

The characters of the genus will be best given under the head of the species.

Distribution and number of species.—Besides the three Indian species described below, there is the *Hyænarcos insignis* of Gervais,² from the lower pliocene of Montpellier; and a specifically undetermined form from the upper miocene of Alcoi, in Spain.³ The so-called *Hyænarcos hemicyon* of the same writer it has been shown above (p. 202) should probably be referred to a distinct genus, under the name of *Dinocyon*, connecting the bears with the dogs. From the upper pliocene (Red-Crag) of England Prof. Flower has described⁴ some molar teeth, which were regarded as specifically indistinguishable from the typical *Hyænarcos sivalensis* of India. The Indian specimens are exclusively confined to the Sind, Punjab, and Sub-Himalayan Siwaliks. In an address on the "Introduction and Succession of Vertebrate Life in America,"⁵ Prof. O. C. Marsh mentions (p. 46) that the genus occurs in the pliocene of South America; Prof. Marsh has informed the present writer that the authority for this statement rests with Mr. Wallace,⁶ but the source of his information is unknown.

Putting aside as somewhat doubtful its alleged occurrence in America, the genus evidently had a very wide geographical range in the Old World, and in time ranged from the period of the upper miocene to the upper pliocene.⁷

Species 1. *HYÆNARCOS SIVALENSIS*, Falc. and Caut.

Synonyms. *Ursus sivalensis*, Falc. and Caut.

Agriotherium sivalense, Wag.

Amphiarcos sivalensis, Blain.

Sivalarcos sivalensis, Blain.

History.—The history of this species is the same as that of the genus; the only addition that need be made is that in 1877 the present writer briefly described⁸ a mandible, and in the following year⁹ a maxilla of *Hyænarcos*, which were then referred to the present species; these specimens are, however, now considered as specifically distinct, and will be described below.

Cranium.—The typical cranium is now in the British Museum (No. 39,721), and is figured of one-third the natural size in figures 1, 1a, 1b, of plate O of the "Fauna Antiqua Sivalensis": it is also figured, of one-fourth the natural size, in the "Palæontological Memoirs" (pl. XXVI., fig. 1). The dentition of one side is figured, of the natural

¹ Pictet in his 'Paléontologie' suggested that *Anyzodon* of Falconer and Cautley ('J. A. S. B.', vol. IV., p. 707) was the same as *Hyænarcos*: the former name was, however, applied to the so-called *Eukhydriodon* (vide supra, p. 196)

² *Op. cit.*, p. 209.

³ *Ibid.*, p. 210.

⁴ *Op. cit.*

⁵ New Haven, Conn., 1877.

⁶ "The Geographical Distribution of Animals," London, 1876, vol. I., p. 146.

⁷ Assuming that the crag fossil is not 'derived.'

⁸ 'Records,' vol. X., p. 33.

⁹ *Ibid.*, vol. XI., p. 103.

size, in figure 1c of the first-mentioned plate; and, of three-fourths the natural size, in figure 2 of the second plate. The dentition is also figured from the lateral and palatal aspects, of one-third the natural size, in plate CXXXI. of Prof. Owen's "Odontography." In figure 5 of plate XXX. of the present volume the dentition of the left side (the canine having been restored from the opposite side) is figured from the palatal aspect, of the natural size.

In this specimen the carnassial (pm. 4) and the two true molars are perfect on the left, and but slightly damaged on the opposite side. Both canines are present, that of the right side being nearly perfect. The alveoli of the premolars and incisors are distinct, although the teeth themselves have dropped out. "The only considerable deficiencies are in the posterior and lower part of the occiput, both zygomatic arches, and in the lower end of the nasals, where a fissure extends across the face on both sides towards the orbits."

The incisors, as indicated by their alveoli, were six in number, and the external pair were larger than the others, as is usual in the family. The canines are of huge size, and present a sub-oval section: the right canine is worn down at the apex, indicating that the skull belonged to an aged animal. The antero-posterior diameter of its base is 1.4, and the transverse 1 inch. Behind the canine there are three alveoli, which are considered by Dr. Falconer to have carried the second and third premolars (pm. 2 and pm. 3), the first of this series being absent, and there being no space for it between the canine and pm. 2. This view implies that pm. 3, in place of being single-fanged as in *Ursus*, must have been implanted by two distinct fangs. The probable correctness of this view is indicated by the circumstance that in the lower jaw pm. 4 (biting against pm. 3) is proportionately larger than in *Ursus*; being in fact so large that, as will be shown below, it was mistaken by Prof. Owen for the carnassial: this indicates that pm. 3 must have been a relatively large tooth. The occurrence of two fangs to pm. 3 in the allied American *Areotherium* (*vide infra*), also confirms this view. *Hyanarctos sivalensis*, therefore, differs from the true bears by the suppression of pm. 1, and the larger size of pm. 3: the presence of two fangs to the latter is a canine character, exhibited by *Cephalogale*.

The three hinder cheek-teeth present the most marked distinction from the corresponding teeth of *Ursus*. The carnassial (which in the specimen is considerably worn) is relatively large, and slightly exceeds the length of either of the true molars: in this respect it differs from the corresponding tooth of *Ursus*, which is always shorter than m. 1; whence *Hyanarctos* is classed as *megalo-* and *Ursus* as *meionacrodont*. The blade of this tooth has posteriorly the two main lobes corresponding to those of the ursine tooth (pl. XXVIII., fig. 3), while in advance of these there is a talon, or another lobe, which is altogether unrepresented in the latter, and corresponds to the first lobe of the Hyæna's tooth (pl. XXXV., fig. 2, pm. 4): in describing this tooth in *Hyanarctos* it will be well to allude to this anterior division of the blade as a talon. The tubercular portion of the tooth is well developed, and

forms a bulge on the inner side of the blade, extending from a little in advance of the first lobe of the latter nearly to the hinder end of the tooth. On the outer surface of the blade there is a distinctly marked cingulum. It is from the somewhat distant resemblance of this tooth to the upper carnassial of the hyæna that the generic name *Hyenactos* is derived: the absence of the least trace of hyænine affinities in the form of the tubercle of the carnassial, and in the rest of the dentition of the latter, renders the name a somewhat unfortunate and misleading one, although a change would probably only lead to further confusion.

The two true molars, in place of being oblong, as in the true bears, with their length greater by a third than their breadth, are very nearly square. The penultimate (m.1), if anything, is longer than the last; the reverse of this arrangement prevailing in *Ursus*. This tooth carries two distinct cusps on the outer side, and internally a ridge indistinctly divided into two or three minor cusps: it is somewhat narrower internally than externally, and has a distinct cingulum on the outer side. It is correctly remarked by Dr. Falconer that the large size of the outer cusps, or lobes, of this tooth, and the presence of a ridge on the inner side, indicates the commencement of a transition from the corresponding tooth of the true bears to that of the dogs;—a transition which will be noticed in the other teeth of the succeeding species. The last true molar (m.2) is also approximately square, and has the same general disposition of its cusps as in the preceding tooth: at its postero-internal angle it has a slight backward prolongation, homologous with the produced talon of the corresponding tooth of *Ursus*.

Regarding the cranium itself, this is larger than that of all species of *Ursus*, excepting perhaps some specimens of *U. spelæus*: its total length when complete is estimated at least at 19 inches. In the profile of the cranium “the most striking feature is the almost rectilinear outline, and absence of any noticeable curvature. From along the nasals to between the infra-orbital processes is almost a straight line. There is but a trifling degree of convexity from that backwards; and the sagittal crest rises in a very prominent ridge above the parietals. No species of bear has so straight a cranium.” The polar bear makes, however, the nearest approach in this respect. The frontals are extremely broad; and the orbits are also large and placed obliquely: their longest diameter is 3.1 inches. The anterior border of the orbit extends only a slight distance in advance of the hinder border of m.2; in which respect the fossil approaches nearest to *Ursus labiatus*. The palate is vaulted both transversely and antero-posteriorly; in the former character approaching nearest to *Ursus theobaldi*. The line of the molar alveoli is markedly convex, whereas in all true bears it is straight. The posterior free border of the palatines is placed nearer to the anterior zygomatic root than in *Ursus*. There are three infra-orbital foramina for the facial branch of the fifth nerve. The condition of the base of the skull does not admit of comparison with the skulls of *Ursus*. The dimensions of the specimen are as follows, *viz.*:—

Width at post-orbital processes	5.45
Interval between incisors and the same	9.3
Width between orbits	4.7
" over canines	4.8
Length from incisive alveoli to posterior margin of palate	7.3
Width of palate between carnassials	3.35
Interval between canines	2.7
Length of last three cheek-teeth	3.44
Length of pm. 4	1.3
Width " " " (at middle)	0.78
Length " m. 1	1.2
Width " " "	1.05
Length " " 2	1.1
Width " " "	1.2
Antero-posterior diameter of canine	1.7
Transverse " " "	1.0

Mandible.—The one known specimen of the mandible of this species was also obtained by Messrs. Falconer and Cautley from the typical Siwaliks, and is now in the British Museum (No. 39,722). It comprizes the greater part of the horizontal ramus of the right side; and is figured from the outer side (reversed) in plate O, fig. 2 of the "Fauna Antiqua Sivalensis" ($\frac{1}{3}$), and in vol. I., plate XXVI., fig. 3, of the "Paleontological Memoirs" ($\frac{1}{4}$): it is also figured from the dental aspect in fig. 2a. of the former plate ($\frac{1}{4}$), and in figure 4 of the latter ($\frac{3}{4}$): and in plate CXXXI., figs. 3 and 4 of Prof. Owen's "Odontography" ($\frac{1}{3}$). According to the description of Dr. Falconer this specimen is broken off where the canine emerges from its alveolus; the embedded portion of that tooth presenting an antero-posterior diameter of 1.6 inches, and a transverse of 0.95 inch. The cheek-teeth are six in number, but of the two first and the last only the alveoli remain. The teeth are much worn, indicating the advanced age of the animal. The first alveolus is placed a short distance behind the canine, and consists of a single cavity, which probably bore the second premolar ($\overline{\text{pm. 2}}$): there is no indication of the existence of $\overline{\text{pm. 1}}$, which is commonly developed in *Ursus*. The second alveolus is placed very close to the first, and also to the succeeding tooth: it must have carried the third premolar ($\overline{\text{pm. 3}}$); and there could not have been another tooth between this and the first alveolus. The fourth premolar is a distinctly trilobed tooth, and is relatively larger than in the genus *Ursus*;—being in fact about $\frac{3}{4}$ the length of m. 2, whereas in the latter it is about $\frac{1}{2}$ the same length. From the relatively large size of this tooth it is inferred, as already mentioned, that the two alveoli in advance of the upper carnassial indicate that pm. 3 was a relatively large tooth inserted by two fangs. "The antepenultimate or carnassier is so defaced¹ as to give no indication of form to notice, except its length. The penultimate or first tubercular molar [m. 2] is oblong. It is broader for its length than generally holds in the genus [*Ursus*], and the crown is less complicated with tubercles. Of the rear tubercular (m. 3) the socket alone remains, the tooth having fallen out. It is situated with considerable obliquity to the rest of

¹ Misprinted *defaced* in Dr. Falconer's memoir.

the series in the root of the ascending portion of the ramus. The alveolus is inconsiderable, and the tooth appears to have been comparatively small. The inferior border of the jaw is markedly convex antero-posteriorly; and the line of the molar alveoli is somewhat concave in the same direction. The dimensions of the specimen are as follows, *viz.*:—

Extreme length of the fragment	10·3
Depth at pm. 2	2·5
„ „ m. 1	3·0
Thickness at m. 2	0·9
Interval between canine and pm. 4	1·3
Length of three true molars	3·25
Interval between canine and hinder end of m. 3	5·35
Length of pm. 4	0·9
Width „ „ „	0·5
Length „ m. 1	1·35
„ „ „ 2	1·15
Width „ „ „	0·75

The most characteristic point in the molar dentition of this specimen, after the large size of pm. 4, is the relatively large size of $\overline{m.1}$, which much exceeds the length and width of $\overline{m.2}$, whereas in the true bears the former tooth is always much wider than the latter, and is either shorter (*U. arctos*), or very slightly longer (*U. torquatus*). In the description of the next species it will also be shown that the carnassial is of a very distinct type from the corresponding tooth of the true bears, being, as in the upper jaw, of a much more carnivorous type of structure.

It should be remarked that in describing this specimen Prof. Owen came to the conclusion that the teeth here respectively regarded as $\overline{pm.4}$, $\overline{m.1}$, and $\overline{m.2}$, should be classed as $\overline{m.1}$, $\overline{m.2}$, and $\overline{m.3}$. The incorrectness of this view is proved by the presence of the empty alveolus behind $\overline{m.2}$ ($\overline{m.3}$ of Prof. Owen), and by the fact that the first of the three remaining teeth is far less worn than the second, indicating that the one is a premolar, and the other a true molar. Should further proof be required, it will be found in the teeth of the perfect mandible of the next species (pl. XXXI.).

Femur.—In plate XXIX., figures 1, 1a, 1b, there are given three views of the right femur¹ of a large ursoid animal obtained from the Siwaliks of the neighbourhood of the Ganges valley, and referred by Dr. Falconer to the present species.² The specimen is now in the British Museum (No. 39,723), and is almost perfect, although it has been fractured in the lower third of the shaft. In figure 2 of the same plate there has been figured, on the same scale, a right femur of *Ursus spelaeus*, for the convenience of comparison. The Siwalik specimen certainly belongs to a carnivore, and comes nearest to the femur of the bears: as there is no other known Siwalik carnivore but *Hyenarctos* of sufficient size to have possessed such a femur, it may be pretty safely referred to that genus; and as it was obtained from the same region as the skull and mandible of *H. sivalensis*, it may probably be referred to that species.

¹ All the figures on this plate are copied from plate O of the "Fauna Antiqua Sivalensis."

² "Palaeontological Memoirs," vol. I., p. 552.

The femur of *Hyanaretos* is distinguished from that of *Ursus* by its greater general stoutness, and by the shaft being broader and flatter, with the terminal expansions proportionately much less developed: the 'head' has moreover a much shorter and less well-defined 'neck,' and is placed more nearly in continuation of the long axis of the shaft. The great trochanter (*left side of top of figures 1 and 2*) also projects higher and is generally larger; while the small trochanter is much less distinctly developed, and is invisible from the anterior aspect, in which it forms a well-marked feature in the bear (*right side of figure 2, below the 'head'*). The trochlear surface for the patella extends higher up on the shaft of the bone in the Siwalik specimen than it does in *Ursus*. The excessive stoutness of the femur of *Hyanaretos* indicates probably that that animal was of a more ponderous type than any existing bear. The shortness of the 'neck' seems also to indicate that the motion of the upper part of the hind limb was more nearly confined to one plane than is the case in *Ursus*; whence it is not improbable that *Hyanaretos* was unable to ascend trees.

Radius and ulna.—In figures 4, 4a, 4b, of plate O of the "Fauna Antiqua Sivalensis" there is represented the greater part of the conjoint right radius and ulna of a large carnivore, referred by Dr. Falconer to the present species. The specimen, which was collected by Messrs. Baker and Durand from the Siwaliks, is now in the British Museum (Nos. 39,725-6): the great stoutness of these bones is in harmony with the characters of the femur.

Metacarpal and phalangeal.—In figures 6, 6a, 6b, 6c, 6d, and 7, 7a, 7b, of the last quoted plate there are represented two fragments of bones of the fore or hind foot of a Siwalik carnivore, which are also referred by Dr. Falconer to the present species: these specimens are now in the British Museum (No. 37,147).

Alleged axis.—In figures 3, 3a, 3b, 3c, 3d, of the same plate there is represented an axis vertebra from the Siwaliks, now in the British Museum (No. 37,143), which is referred by Dr. Falconer to the present species. This bone is much more elongated than in the true bears, its length being 4 inches and its breadth in the middle 1·5 inches; the corresponding dimensions of the axis of *U. horribilis* being 2·7x2·0 inches. It appears to be not impossible that this bone may really belong to one of the Suina.

Distribution.—The foregoing specimens comprehend all the known Indian remains that can be referred to the present species; and were all obtained from the typical Siwalik hills. It has been already mentioned that Professor Flower has described some molars from the Red Crag, which were considered not improbably to belong to the present species: it will, however, be shown below that this provisional reference may be doubtful.

The general affinities of the genus may be more conveniently noticed after the description of the other species.

Species 2. *HYÆNARCTOS PUNJABIENSIS*, n. sp., *nobis*.

History.—The name of this species is mentioned here for the first time, the specimens on which it is founded having been previously referred to the last species.

Upper molars.—In figure 2 of plate XXX. there are represented five associated upper cheek-teeth belonging to the present genus, which were collected by Mr. Theobald in the Siwaliks of Asnot, in the Punjab, in the winter of 1877: they are the specimens briefly alluded to on page 103 of the Xth volume of the "Records." When these teeth came into the hands of the present writer they exhibited signs of having been recently hammered out of their sockets, and there is little doubt but that they were broken from a skull by the villagers who brought them to Mr. Theobald. In order to preserve them as associated they have been embedded in a block of plaster.¹ The enamel of the teeth has not been perforated by wear, indicating that the animal to which they belonged had only just attained the full development of its permanent dentition. The specimens comprize the carnassials (pm. 4) of either side; and two molar teeth of opposite sides, which from comparison with *Hyænaretos sivalensis* have been found to be the first true molars (m. 1): the tooth of the right side has been crushed and split. In the left-hand corner of the tablet there is a small conical tooth, which is evidently an early premolar. It will be remembered that it has been inferred that in *Hyænaretos sivalensis* pm. 3 was a relatively large tooth, inserted by two fangs; it is accordingly pretty certain that the tooth under consideration cannot be pm. 3 (especially as pm. 4 is of large size), and it may therefore be considered as pm. 2. It differs from the corresponding tooth of *H. sivalensis* by being inserted by two distinct fangs, and in this respect differs from all species of *Ursus*, and agrees with *Cephalogale* and *Canis*.

The carnassial (pm. 4) has the blade consisting of two main lobes (*p. m.*), corresponding to the main lobes of *H. sivalensis*: the anterior talon (*a*) is, however, much less developed than in the latter²; its respective length in the two specimens being 0.23 and 0.33 inch. The inner tubercular portion of the two specimens also differs considerably: thus in the Punjab tooth this part ends posteriorly at the division between the two main lobes of the blade, whereas in *H. sivalensis* it extends as far back as the middle of the hind lobe. In the former the tubercle extends as far forwards as the anterior border of the first lobe, whereas in the latter it does not extend farther than a little beyond the middle of the same lobe. The tubercle of the former is also altogether larger than that of the latter; and the one tooth lacks the distinct external cingulum of the other. The external contour of the base of the crown is regularly convex in the Punjab specimen, but in *H. sivalensis* has a marked concavity opposite the division between the two main lobes of the blade.

¹ The carnassials should have been placed slightly obliquely to the true molars.

² In the present specimen the carnassial of the right side is not evenly set in the plaster: the tooth of the left side corresponds in position with the figured carnassial of *H. sivalensis*.

Some of these differences are exhibited by the following measurements :—

	Specimen.	<i>H. sivalensis</i> .
Length of pm. 4	1·25 ..	1·3
Width „ „ at middle	0·88 ..	0·78
Length „ tubercle of ditto	0·23 ..	0·33
Height of first lobe of blade of ditto	0·78	

With regard to m.1 the writer had at first considerable difficulty in knowing which was the anterior side of the teeth: it appeared, however, from another specimen with the teeth in position, and also from *H. palvindicus* described below, that the first external lobe is the tallest and narrowest: accordingly the first true molars of the specimen were placed as figured; the outline (m. 1*) showing the relative size of the outer lobes of the left tooth. This tooth has a close general resemblance to the corresponding molar of *H. sivalensis* (as far as the worn condition of the latter admits of comparison), but is distinguished by the more quadrate form of the crown, and by the convexity of the posterior border: it is also distinguished by the smaller degree of development of the external cingulum, and the somewhat less bold form of the outer lobes: the most marked distinction is, however, the closer approximation in the Punjab specimen of the central line of the outer lobes and the internal ridge, this interval being respectively 0·41 and 0·48 inch: this causes the internal ridge to be placed further away from the inner margin of the tooth in the Punjab specimen.

Hyenarectos from the Red-Crag.—It will be most convenient to consider here the

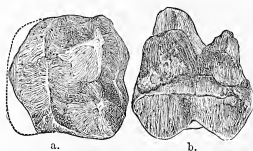


Fig. 5. *Hyenarectos*, sp. 1st right upper true molar from the Red-Crag: *a* from the masticating surface, *b* from the outer side: the dotted line in *a* represents the outline of a complete tooth from the same formation. Ipswich Museum.

molar of *Hyenarectos* from the Red-Crag described by Prof. Flower in the notice already quoted, and provisionally referred to *H. sivalensis*. By the courtesy of the Council of the Geological Society, the writer has been permitted to reproduce the woodcut of this tooth (fig. 5), which is described as a first upper true molar of the right side.¹ It will be seen from the figures that this tooth agrees with *H. sivalensis* in the well-marked external cingulum, the bold outer lobes, and the wide interval separating the median line of the latter, and the internal ridge. It resembles the Punjab tooth in the outline of the crown, although the concavity of the anterior border is not observed in the latter: the internal ridge is placed farther away from the inner border of the crown than in the Punjab tooth, and, therefore, in this respect differs very markedly from *H. sivalensis*. The Crag specimen also differs from the Punjab tooth by the internal ridge being markedly convex antero-posteriorly, in place of nearly level, with a distinct tubercle posteriorly.

Since it will be shown below that the first true molar of the Punjab specimen,

¹ The position of *a* in fig. 5 has been reversed from the position it occupied in Prof. Flower's memoir, in order to facilitate comparison with the Punjab tooth: it will be noticed that in the former the hinder external lobe is more worn than the anterior one, as is the case with many of the bears.

although differing in a comparatively slight degree from the corresponding tooth of *H. sivalensis*, yet belongs to a markedly distinct species; and since the Crag tooth differs from both the above in nearly the same degree as they do from one another, it seems to the writer that the evidence for identifying the Crag tooth with *H. sivalensis* is by no means certain, and he is rather inclined to think that it may belong to a species distinct both from the latter and from the Punjab species, although it will require more complete specimens of the dentition before the question can be finally decided.

Second maxilla.—In the Indian Museum there is a specimen of a left maxilla of a species of *Hyenavetos* (No. D. 12), collected by Mr. Theobald in the Siwaliks of the Punjab, containing the last three cheek-teeth, the two first of which agree in all respects with those of the Asnot specimen. The teeth are in too damaged a condition to afford a good figure of the whole; but the specimen is important in showing the last true molar, of which a woodcut (fig. 6) is here given. This tooth differs very markedly from the corresponding tooth of *H. sivalensis* in having its postero-internal angle with a more marked production, being in this respect very close to the corresponding tooth of *Arctotherium* (woodcut, fig. 7).



Fig. 6. *Hyenavetos punjabensis*, Lyd. 3rd left upper true molar, from a specimen of the maxilla: from the Siwaliks of the Punjab. Ind. Mus. (No. D. 12).

The fragment also shows that the orbit extended farther forwards than in *H. sivalensis*; its anterior border reaching nearly as far as the middle of *m. 1*. This causes *m. 2* to be placed relatively farther back, whence on the palatal aspect it extends some distance behind the anterior zygomatic root, in place of being entirely in advance of it as in *H. sivalensis* ("F.A.S.," pl. O, fig. 1a). In the palatal aspect of the Punjab specimen no portion of the orbital surface of the maxilla comes into view, as it does so largely in the last-named species. The Punjab specimen also differs in the much smaller vertical depth of the anterior zygomatic root, the respective diameters being 1·75 and 2·5 inches: this probably indicates that the Punjab species was an animal with a less ponderous skull; an inference which will be confirmed by the study of the mandible.

The dimensions of the teeth of the Asnot specimen (No. D. 6), of the specimen under consideration, and of those of *H. sivalensis*, are compared together in the following table:—

	Present species.		<i>H. sivalensis</i> .
	D. 6.	D. 12.	
Length of last 3 cheek-teeth		3·48 ..	3·44
" pm. 4	1·25	1·19 ..	1·3
Width " " (at middle)	0·88	0·94 ..	0·78
Length, m. 1 (outer ridge)	1·18	1·2 ..	1·2
" " " (inner ")	1·12	1·18 ..	0·98
Width " " "	1·08	1·08 ..	1·05
Length " " 2 (inner ridge)		1·11 ..	1·1
" " " (outer ")		0·96 ..	1·0
Width " " "		1·05 ..	1·2

The second specimen exhibits the great width of the tubercle of $\overline{pm.4}$ very characteristically.

Mandible.—In figures 1, 1a, of plate XXXI. of the present memoir there are given two views of a nearly complete mandible belonging to the present genus which is of very great importance, since this and the fragment represented in figure 2 of the same plate, are the only known specimens exhibiting the complete lower carnassial. The nearly complete mandible is the specimen alluded to on page 33 of the Xth volume of the "Records," and was obtained by Mr. Theobald from the Siwaliks of Asnot, in the Punjab: it is now in the Indian Museum (No. D. 8). The general similarity of the specimen to the mandible of *Hyanarctos sivalensis* leaves not the slightest doubt but that it belongs to that genus. The almost unworn condition of the molars, the precise similarity in the mineralogical condition of the specimens, and the fact of their having been obtained from the same locality (though not in the same season) leaves little doubt in the mind of the writer that the mandible belonged to the same individual as the upper molars represented in figure 2 of plate XXX. Be this, however, as it may, the specimens having been obtained from the same locality, and both (as will be shown below) differing from the corresponding parts of *H. sivalensis*, and agreeing precisely in size and general characters it is tolerably certain that they belong to the same species.

This magnificent specimen comprizes the nearly complete horizontal ramus of either side; the only damage it has sustained being that the summit of the right canine has been hammered off, and two fragments broken out of the left ramus: these imperfections have been restored in the figure, in which the left ramus is shown only in outline. Behind the canine the specimen shows the base of a small and closely approximated premolar, which must probably be regarded as the homologue of the second premolar of *H. sivalensis*, although differently placed. Behind this tooth there is a long 'diastema,' and then comes the single alveolus of a tooth which must correspond to the third premolar. Behind this there is the broken base of a considerably larger tooth, which, as preceding the carnassial ($\overline{m.1}$), must be $\overline{pm.4}$: this tooth about equalled in size the corresponding tooth of *H. sivalensis*.

The carnassial ($\overline{m.1}$) is a very large tooth which requires somewhat minute description. In the first place this tooth renders it certain that the much-worn long tooth in the lower jaw of *H. sivalensis* is the carnassial, and not, as Prof. Owen considered, the second true molar. The tooth consists of a blade bearing two distinct outer lobes, or cusps (b, c), and an inner cusp (a), behind which is a tubercular portion, which may be most conveniently termed the talon.¹ The two main lobes of the blade are tall, with true sectorial edges. Comparing this tooth with the carnassial of the true bears, such as *U. arctos*, it will be found that it differs by its much greater

¹ There is a slight difficulty in the comparative nomenclature of this part of the lower carnassial. In the true bears it is scarcely differentiated from the blade, while in the hyænas, when present at all, it is reduced to an unimportant talon. In the dogs and *Hyanarctos* it is intermediate between the two. As it is the practice to term this part a talon in the hyænas, it is best to adopt the same nomenclature for the other genera.

proportionate length, and more sectorial character; the latter being of course most marked in the blade. In *Hyænarcetos* the inner cusp of the blade (a) is relatively small and placed in great part posteriorly to the hinder outer lobe (b); whereas in the bears it is much larger and placed completely on the inner side of the hinder outer lobe which is relatively small. This arrangement in *Hyænarcetos* allows the main lobes of the blade to assume a truly sectorial character. It is very noteworthy that Prof. Huxley¹ has recorded an almost identical condition in the dogs, in the less specialized forms of which (*Otocyon*) the inner cusp (anterior internal cusp of Prof. Huxley) of the blade of $\overline{m.1}$ is relatively large, and placed on the inner side of the hinder outer lobe (anterior external cusp); while in the higher forms e.g. (*Canis lupus*) the former is small and placed posteriorly to the latter. In consequence of these different arrangements the line connecting the summits of the inner cusp and the hinder outer lobe of the blade (cusp-line of Prof. Huxley) is nearly transverse in *Otocyon*, but very oblique in the wolf. The corresponding line is transverse in *Ursus*, and very oblique in *Hyænarcetos*. The talon of the carnassial of the latter has its bounding ridges considerably more developed than in the former.

This tooth very closely resembles the carnassial of *Dinocyon thenardi*²; the only appreciable difference between the two being that the talon is rather more developed in *Hyænarcetos*; and that it carries two minute cusps, in place of one, behind the inner cusp (a) of the blade: these tubercular cusps are much lower than the inner cusp of the blade. The differences between the carnassials of these two genera are indeed much less marked than those existing between the corresponding teeth of certain genera of the modern dogs and foxes. From the lower carnassial of *Canis lupus* the corresponding tooth of *Hyænarcetos*, except in respect of size, scarcely differs more than by the slighter development of the cusps of the talon: the blade is, however, somewhat lower and stouter; but the whole tooth is more like that of a dog than that of a bear.

The second true molar ($\overline{m.2}$) much resembles the corresponding tooth of *Ursus arctos*, but is relatively shorter and broader, and has its cusps and ridges more developed. In shape it is very close to the corresponding tooth of *Dinocyon thenardi*: it also resembles the corresponding tooth of *Amphicyon* (pl. XXXII., fig. 4), but the cusps of the latter are more distinct; a character still more marked in the true dogs. In the different stages of wear of the two specimens it is impossible to draw any distinction between this tooth and the second molar of *Hyænarcetos sivalensis*.

The third true molar ($\overline{m.3}$) has an almost circular crown, and in this respect is nearer to the true dogs than to either *Ursus* or *Dinocyon*.

The canine is considerably smaller than the canine of *Hyænarcetos sivalensis*, as may be seen by the measurements given below, and by a comparison of the figure with that of the upper jaw of the latter: it is also distinguished by having a more flattened inner surface, bounded by well-defined edges. This surface is more flattened

¹ 'Pro. Zool. Soc.,' 1880, p. 260, fig. 13, and elsewhere.

² Filhol, *op. cit.*, pl. III., figs. 4-5.

than in *U. arctos* (which again is more so than in *U. torquatus*), and more nearly resembles the corresponding part of the carnassial of *Canis*. The lower canine of *Dinocyon thenardi* is unknown; but the upper is sub-cylindrical.

In regard to the shape of the mandible, the inferior border is straight, in place of being convex as in *Hyænaretos sivalensis*. The vertical depth of the jaw considerably exceeds the length of the carnassial in which respect the specimen agrees with *Ursus*, *Dinocyon*, and *Cephalogale*,¹ and differs from *Amphicyon* and *Canis*.

The dimension of the specimen are compared below with those of *Hyænaretos sivalensis* :—

	Specimen.	<i>H. sivalensis</i> .
Depth at pm. 2	2.05	.. 2.5
" " m. 1	2.15	.. 3.0
Thickness at m. 2	0.94	.. 0.9
Interval between canine and pm. 4	1.45	.. 1.3
" " pm. 2 " " 3	0.75	.. 0.2
Length of 3 true molars	3.52	.. 3.25
Interval between canine and hinder end of m. 3	5.83	.. 5.35
Length of pm. 4	0.9	.. 0.9
Width " " " . . . . .	..	.. 0.5
Length " m. 1	1.68	.. 1.35
Width " " "	0.84	..
Length " 2	1.25	.. 1.15
Width " " "	0.9	.. 0.75
Length " 3	0.67	..
Width " " "	0.67	..
Antero-posterior diameter of canine	1.13	.. 1.6
Transverse " " "	0.9	.. 0.95
Length of ditto	2.1	..

These dimensions show that the carnassial is considerably longer than that of *H. sivalensis*, and m. 2 considerably broader: the jaw also has a much less vertical height, indicating that this species was a more slender-jawed animal than the former;—a conclusion in harmony with that drawn from the upper jaw.

Sind specimen.—There is in the Indian Museum (No. D. 28) a much battered fragment of the symphyseal extremity of the right ramus of the mandible of a species of *Hyænaretos*, collected by Mr. F. Fedden in the lower Manchhars (Siwaliks) of Sind, showing the broken base of the canine and pm. 2. From the position of the latter tooth the specimen not improbably belongs to the present species.

Distinctness as a species.—The foregoing comparisons leave no reasonable doubt but that the specimens under consideration belong to a species distinct from *Hyænaretos sivalensis*; and also probably distinct from the *Hyænaretos* of the Red Crag. With *H. insignis*, of Montpellier,² it appears to be more nearly related: it seems, however, to be distinguished by the greater backward prolongation of the postero-internal angle of m. 2; and the inner ridge of m. 1 seems raised into more distinct cusps in the European form, while the inner and outer ridges are less approximated: the upper carnassials of the two agree in having a large internal tubercle, but the

¹ Filhol, *op. cit.*, pl. II., fig. 2.

² Gervais, "Zool. et Pal. Franç.," pl. LXXXI., figs. 3-7.

anterior talon of the Indian form is smaller, though in profile the two appear very similar. The two are further distinguished by pm.2 having a single fang in *H. insignis*, and two fangs in the Punjab form. The Spanish *Hyænarctos* is too imperfectly known for certain specific determination: the carnassial has, however, a very large internal tubercle like the present species; but its anterior talon seems to be larger.

As the present species cannot be identified with either of the other named species, it is entitled to a separate name, and the name *H. punjabiensis* is accordingly proposed for it.

Distribution.—The remains described above, which, with one exception, came from the Punjab, are all that can be referred to the present species: the one exception, the specific determination of which is doubtful, came from Sind. From the occurrence of the remains of this species in the Punjab and Sind alone, and of those of *H. sivalensis* in the more easterly Siwaliks it is possible that the two species were limited in their range. In other species there are not wanting signs of similar limits in the range of the Siwalik carnivores.

Species 3. *HYÆNARCTOS PALÆINDICUS*, n. sp., *nobis*.

History.—On pages 103-4 of the XIth volume of the "Records" mention is made of the maxilla of a *Hyænarctos* specifically distinct from *H. sivalensis*, for which the name *H. palæindicus* is proposed: that specimen, with some others, forms the subject of the present notice.

Maxilla.—The maxilla mentioned above is represented in figure 1 of plate XXX.: it belongs to the right side, and contains the last three cheek-teeth; and was obtained by Mr. Theobald from the Siwaliks of the Punjab. The teeth are perfect, with the exception of the summit of the first main lobe of the carnassial, and have been but very slightly abraded by wear. The carnassial (pm. 4) is constructed on the same general plan as the corresponding tooth of the two preceding species, but is shorter and wider; its inner tubercle and anterior talon being largely developed. From the form of the alveolus of one of the specimens of *Dinocyon hemicyon* figured by Prof. Gervais¹ it seems that the carnassial of that species (which in the form of its true molars connects the present species with that genus) was constructed on the *Hyænarctos* type, having (as is seen from the position of the inner fang) a large internal tubercle: the step from this type to the carnassial of *Cephalogale*,² in which the tubercle, though confluent with the blade, is yet large and placed opposite the first lobe of the blade, is but small; and the latter leads on to the carnassial of the true dogs, in which the tubercle is very small, and placed at the antero-internal angle of the crown.

The first true molar (m. 1) of the specimen under consideration differs from the corresponding tooth of both the preceding species by being relatively shorter, and by the internal angles being more rounded off: in both these respects *H. sivalensis* is nearer to the present specimen than is *H. punjabiensis*. The specimen is also marked by the greater prominence of the outer lobes and the inner ridge; the latter showing a distinctly marked cingulum on its inner side, which is entirely wanting in *H.*

¹ *Op. cit.*, pl. LXXXI., fig. 8 (*Hyænarctos hemicyon*).

² *Filhol, op. cit.*, pl. II., fig. 4.

punjabiensis, although faintly marked in *H. sivalensis*. On the external surface there is a very bold cingulum (partly damaged in the specimen) extending across both lobes of the blade: this cingulum is present in *H. sivalensis*, but does not extend across the anterior lobe.

In all the points in which this tooth differs from the first true molar of the other species of *Hyenaretos*, it approaches the more dog-like *Dinocyon*. In the first true molar of the latter¹ the antero-posterior shortening is carried to a still greater extent; the inner cingulum is more developed, and the inner transverse ridge rendered less prominent. From this tooth there is but one step to *Cephalogale*,² in which the cingulum is more widely separated from the internal ridge, which assumes a horse-shoe shape; and thence to *Canis* (woodcut, fig. 8), in which the ridge is divided into two distinct cusps.

The last true molar of the specimen differs from the corresponding tooth of the two preceding species of *Hyanarctos* by the oblique truncation of its postero-external angle, and the entire absence of any backward prolongation of the postero-internal angle. In consequence of this the hinder external lobe becomes less distinct and is placed more internally. In respect of the obliquity of the outer ridge, *H. punjabensis* comes nearer to the specimen than the other species. The internal ridge is curved, and has a well-marked cingulum. The absence of any trace of a hind talon to this tooth is one step further away from *Ursus* than is made by the other species of *Hyanarctos*: the oblique position of the line of the external lobes is a dog-like character, displayed in the last molar of *Dinocyon*: in that genus, however, the last molar is smaller antero-posteriorly than the penultimate, although, as in *Cephalogale*, this character is not so strongly marked as in *Canis*. The last molar of the present specimen is, therefore, intermediate between the corresponding tooth of the other species of *Hyanarctos* and *Dinocyon*.

In the following table the dimensions of the specimen under consideration are compared with those of *Hyenarctos sivalensis* and *H. punjabiensis*, and *Dinocyon thenardi* and *D. hemicyon* :—

				H. punjabensis.		H. sivalensis.		Specimen.	D. hemicyon.		D. therapi.
Length of last three cheek-teeth	3-48	.	3-1			
" " pm. 4	1-19	.	1-3	.	1-09	
Width " " " (at middle)	0-88	.	0-78	.	0-81	
Length " m. 1 (outer ridge)	1-18	.	1-2	.	1-06	. 1-05 .. 1-09
" " " " (inner ")	1-12	.	1-18	.	0-98	. 0-75 .. 0-95
Width " " " "	1-08	.	1-08	.	1-05	. 1-14 .. 1-38
Length " " 2 (inner ridge)	1-11	.	1-1	.	1-0	. 0-77 .. 1-02
" " " " (outer ")	0-96	.	1-0	.	1-05	. 0-77 .. 1-05
Width " " " " (anteriorly)	1-05	.	1-1	.	1-13	. 1-04 .. 1-45
" " " " (posteriorly)	0-9	.	1-2	.	0-97	. 0-95 .. 1-15

¹ Gervais, *op. cit.*, pl. LXXXI., fig. 9. Filhol, *op. cit.*, pl. III., fig. 11.

² Filhol, *op. cit.*, pl. II., fig. 4.

The small fragment of the external surface of the maxilla that still remains attached to the specimen, though too imperfect to afford any satisfactory figure, shows that the skull must have differed very considerably from that of *H. sivalensis*, or *H. punjabiensis*. In both those species the external surface of the maxilla extends a considerable distance above the anterior root of the zygoma with but a very slight degree of inward inclination, indicating the straightness of the facial profile in both. In the present specimen, on the contrary, the maxilla is suddenly bent almost at a right angle at the zygomatic root, indicating that the facial profile must have been suddenly angulated at the orbit, in much the same manner as in *Ursus spelæus*.

Distinctness of species.—The foregoing comparisons leave no doubt that the maxilla under consideration belongs to a species distinct both from *H. sivalensis* and *H. punjabiensis*; and as the specimen presents no marked resemblance to *H. insignis* or to the *Hyænarctos* of the English Crag it may be safely referred to a new species, for which the name *palæindicus* may be adopted. The general resemblance of the teeth to those of the more typical species of *Hyænarctos* is so close that the species may, at all events provisionally, be referred to the same genus. It affords a marked step from the more bear-like typical species in the direction of the more dog-like *Dinocyon*.

Upper canine, which may belong to this species.—In figure 3 of plate XXX. there is represented a canine tooth of an ursoid animal obtained by Mr. Theobald from the Siwaliks of the Punjab (Ind. Mus. No. D. 11). From its highly curved form this tooth very probably belongs to the upper jaw, and if so, to the right side. The summit of the crown has been broken off, but the portion remaining shows that this was sub-circular, with a partially flattened posterior surface, bounded by a ridge at the postero-external angle. The tooth is less compressed than the canine of *Ursus*, and is more like that of *Hyænarctos sivalensis*, but much smaller, and with a more regular section: it lacks the marked flattened inner face of the canine of *H. punjabiensis*. Under these circumstances it is not impossible that it may belong to the present species. The profile of the whole tooth strongly resembles that of the canine of *Dinocyon*,¹ but the section of the crown is less elliptical. The antero-posterior diameter of the base of the crown is 0·92, and the transverse 0·87 inch.

Mandible which may belong to the present species.—In figures 2 and 3 of plate XXXI. there are represented two, probably associated, fragments of the mandible of a species of *Hyænarctos* obtained by Mr. Theobald from the Siwaliks of Jabi in the Punjab, which may belong to the present species. The first specimen (fig. 2) is a part of the left ramus, containing $\overline{\text{pm. 4}}$ and $\overline{\text{m. 1}}$; the second (fig. 3) is from the opposite side, and contains $\overline{\text{m. 2}}$. The dimensions of these specimens are compared below with those of the corresponding teeth and jaw of *H. punjabiensis*, viz. :—

¹ Filhol, *op. cit.*, pl. III., fig. 1.

	Specimens.	<i>H. punjabiensis</i> .
Depth at pm. 4	1.72	2.24
" " m. 1	1.6	2.15
Length of pm. 4	0.68	0.9
Width " " "	0.52	
Length " m. 1	1.56	1.68
Width " " "	0.83	0.84
Length " " 2	1.15	1.25
Width " " "	0.89	0.9

These dimensions show that this mandible is much more slender than that of *H. punjabiensis*; while the carnassial and m. 2 are slightly, and pm. 4 is very considerably, smaller than the corresponding teeth of that species. The latter tooth is triangular in outline, and has a compressed conical crown, with fore-and-aft trenchant edges: it lacks the distinct talons of the same tooth in *H. sivalensis*. Though relatively larger, it much resembles the corresponding tooth of some species of *Ursus* (e.g. *U. torquatus*); and is almost precisely similar to its homologue in *Cephalogale*.¹ It differs from pm. 4 of *Canis* by the absence of the two posterior talon-cusps. Besides these differences in size the specimens differ from both the other Siwalik species, by the third premolar (pm. 3), as shown by its alveoli, having had two fangs, in place of a single one. In this respect this mandible differs from *Ursus* and agrees with *Cephalogale* and *Canis*: the corresponding tooth of *Dinocyon* is unknown. In comparison with *H. punjabiensis* the carnassial has its blade shorter in proportion to the talon portion; and on the inner side of the latter one of the two cusps (*immediately to the left of a*, fig. 2) is very much larger,—being nearly of the same size as the postero-internal cusp of the blade (*a*). The second true molar (fig. 3) has its cusps rather more boldly developed than in the corresponding tooth of *H. punjabiensis*, but is otherwise similar. The most remarkable point about the specimen containing m. 2 is, however, that behind that tooth (*left side of fig. 3*), there is not the slightest trace of the alveolus of m. 3. The jaw is unfortunately somewhat broken at the place where that tooth should have been inserted, but enough remains to show that it must have been either completely absent, or reduced to an exceedingly minute size. The total suppression, or minute size of this tooth, is a character totally unknown in *Ursus*, but occurs among the modern dogs (*Cyon*).

Another noteworthy character of the specimen, and one in which it agrees more nearly with the true dogs than with any of the present group of animals, is the comparative slenderness of the mandible. It will be observed that the depth of the mandible only slightly exceeds the length of the carnassial; whereas in *Ursus* and the other species of *Hyenaretos* the former dimension is very greatly in excess of the latter. In *Dinocyon* and *Cephalogale* very similar relations prevail, but in *Canis* and its allies the depth of the mandible is generally either equal to, or less than (*C. aureus*) the length of the carnassial. The generalized genus *Cynodictis* is intermediate in this respect.

¹ Filhol, *op. cit.*, pl. II., fig. 3.

The foregoing comparisons prove conclusively that the mandible under consideration belongs to a species of *Hyænarcos* specifically distinct both from *H. sivalensis* and *H. punjabiensis*. Its somewhat smaller size, and certain canoid characters of the dentition render it not improbable that it may belong to *H. paleindicus*; but if this be not the case it must be referred to a fourth species. As indicative of the former view it is not impossible that the suppression of $\overline{m.3}$ may be correlated with the total absence of the hind talon of $\overline{m.2}$ in *H. paleindicus*.

It is worthy of remark that the four known Siwalik specimens of the skull or upper molar dentition of *Hyænarcos* belong to three distinct species; and that the specifically determinable specimens of the mandible also indicate three species,—probably identical with the others. This indicates the extreme richness in species of the Siwalik Carnivora, and the rarity of their remains; and should serve as a strong inducement to the continued collection of Siwalik fossils.

Distribution.—All the remains that can be referred to the present species have been obtained from the Punjab.

AFFINITIES OF HYÆNARCOS.

Dental formula.—Having now described, as far as they are known, the three Siwalik species of the genus, it remains to take into consideration its general affinities. The dental formula may be represented as follows, viz., I. $\frac{3}{3}$ (?), C. $\frac{1}{1}$, Pm. $\frac{3}{3}$, M. $\frac{2}{(2 \frac{1}{2})-3}$. In all the species, as far as known, $\overline{pm.3}$ was inserted by two fangs: in *H. sivalensis* $\overline{pm.2}$ had one fang, but two fangs were present in *H. punjabiensis*. In both these species $\overline{pm.3}$ had only a single fang, but in the mandible provisionally assigned to *H. paleindicus* this tooth was furnished with two fangs. The upper true molars of *H. punjabiensis* are the most bear-like, and those of *H. paleindicus* the most dog-like; the latter species shows moreover indications of strong canine affinities in its lower premolars.

Comparison with Arctotherium.—In the first edition of the "Zoologie et Paléontologie Françaises,"¹ Prof. Gervais described certain remains of a large bear-like animal from the pleistocene of S. America under the name of *Ursus bonariensis*; and at a later period figured the lower molars under the same name.² In 1860 M. Bravard described the remains of an ursine animal from the same deposits under the name of *Arctotherium latidens*.³ Still later Prof. Gervais published another note,⁴ in which he came to the conclusion that his *Ursus bonariensis* was subgenerically distinct from *Ursus*, and was in all probability specifically identical with *Arctotherium latidens*, Brav.: it was also mentioned that the specific name *bonariensis* had the undoubted priority; and that the genus, or sub-genus, was allied to *Ursus* (*Tremarctos*) *ornatus* of Chili.

¹ Paris, 1848-52, vol. I., p. 189.

² 'Ann. d. Sci. Nat.—Zool.,' vol. III., p. 330.

³ "Catalogue des espèces d'Animaux Fossiles recueillies dans l'Amerique de Sud," Parana, 1860.

⁴ 'Comptes Rendus,' vol. LXV., p. 811. 1867

In the collection of the British Museum there is exhibited the skull and a considerable portion of the skeleton of the *Arctotherium*¹ of Bravard, obtained by him from Buenos-Ayres; and from the comparison of the lower molars of the so-called *Ursus bonariensis* with that specimen, there appears to be no doubt but that, as suggested by M. Gervais, the two are specifically identical: the proper name of the species will, therefore, be *Arctotherium bonariense* (Gerv.).² Recently Professor Cope³ has given a preliminary description of an ursoid skull from the caves of California, which is provisionally referred to the genus *Arctotherium*,⁴ under the name of *A. simum*: this species is said to be distinguished by the absence of any diastema.

After this unavoidable digression, which was necessary to show the proper

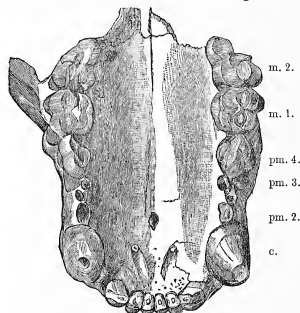


Fig. 7. *Arctotherium bonariense* (Gerv.). Palatal view of a cranium in the British Museum (No. 32,915), from the pleistocene of Buenos-Ayres. $\frac{1}{2}$.

name of the extinct bear of Buenos-Ayres, the comparison with *Hyenarctos* may be undertaken. In the first volume of the "Palæontological Memoirs" there is given a note by Dr. Falconer relating to a comparison which he made between the skull of *Arctotherium bonariense* sent to the British Museum by M. Bravard,⁵ and *Hyenarctos sivalensis*. By the courtesy of the Keeper of the Geological Department of the British Museum, the writer has been enabled to give a woodcut (fig. 7) of the palatal aspect of this fine specimen. The first part of Dr. Falconer's note, referring to the upper dentition, may be quoted at length, and is as follows, viz.⁷ :—

"All the teeth, or their alveoli, present

on both sides, and the number exactly identical with that of *Hyenarctos sivalensis*.

"1. A small premolar [pm. 2], touching the canine is present on the right side.

"2. A two-fanged premolar [pm. 3], the alveoli only remaining on both sides.

"3. A tooth [pm. 4] resembling the third of *Hyenarctos*, but more worn and broader for the length. Instead of possessing three external cusps, the flat summit,

¹ The specimen is labelled *Arctoidotherium*, Brav., MSS.: the author not having seen M. Bravard's memoir is unaware whether the name was originally given as *Arctotherium* or *Arctoidotherium*: it is, however, quoted as *Arctotherium* by M. Gervais.

² Unless the name *Ursus brasiliensis*, Lund., which probably belongs to the same species has the priority, in which case the name will be *A. brasiliense* (Lund).

³ 'American Naturalist,' Dec., 1879.

⁴ Mr. Cope mentions *Arctotherium*, Gerv., in place of *Arctoidotherium*, Brav.

⁵ pp. 329-30.

⁶ In the original note the Buenos-Ayres specimen is simply alluded to as a "huge ursine head," without any generic or specific name.

⁷ In quoting this note an obvious misprint has been corrected: several slipshod sentences have been put into better form, and some of the terms employed altered to those employed in this memoir.

which is much worn, only shows the disks, which are confluent, of two lobes, the anterior small talon, which is so well defined in *Hyænaretos*, being wanting; but there is the great agreement of a mesial inner tubercle placed opposite the transverse axis, as in *Hyænaretos*.

"4. A square molar [m. 1], consisting of two outer and two inner cusps, the outer pair having the discs confluent, and also the inner. It is more moderate in form than the Siwalik tooth, and resembles the last of *Hyænaretos*.

"5. A last molar [m. 2], as in *Hyænaretos*, which, instead of being quadrate, has the inner posterior discous surface produced behind, so as to make the tooth oblong instead of square. The outer line, as in the Siwalik fossil, consists of two tubercles."

The upper carnassial of *Arctotherium* is essentially that of a bear, the lobes of the blade not having the marked sectorial character of those of *Hyænaretos* (compare *woodcut fig. 7*, and *plate XXX., fig. 2*): that character being most marked by the deepness of the cleft between the two. The true molars of the former are intermediate between those of *Ursus* and *Hyænaretos*: the form of m. 2 approaching nearest to its homologue in *H. punjabiensis*.

In the palate the backward extension of m. 2 behind the anterior root of the zygoma in *Arctotherium* is in excess of that which occurs in the last-named species, and is, therefore, very different from *H. sivalensis*. The facial portion of the skull is much shorter than that of the latter; the profile of the face markedly concave, and the frontal region more prominent: in the latter characters there seems to be a resemblance to *H. paleindicus*, but the dentition of that form is widely different.

In the mandible there seem to have been four premolars;¹ each of the first three inserted by a single fang, but the fourth having two fangs: the latter tooth is shorter and thicker than the corresponding tooth of *H. sivalensis*. The number, and mode of implanation of the premolars is the same as in *Ursus*. The carnassial² is of a much less distinctly sectorial nature than that of *Hyænaretos*, being about intermediate between that tooth and the carnassial of *Ursus*. The second and third premolars are also intermediate between the corresponding teeth of the two genera.

From the suppression of pm. 1, the double roots of pm. 3, the squareness of m. 1, and the smaller extent of the backward prolongation of the talon of m. 2, it is pretty certain that the South American fossil is generically distinct from *Ursus*, and the above-mentioned comparisons leave as little doubt that it is equally distinct from *Hyænaretos*: it forms in fact a genus almost precisely intermediate between the other two: *H. punjabiensis* being the species of *Hyænaretos* most nearly related to it. From the study of the teeth Dr. Falconer came to the conclusion that while *Hyænaretos* was probably carnivorous, *Arctotherium* subsisted on a vegetable diet. The writer is unable to see that *Arctotherium* presents any especial relationship to *Ursus ornatus*.

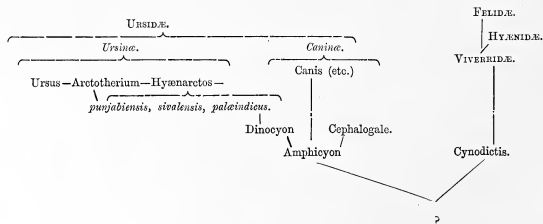
¹ There is some confusion in Dr. Falconer's note on these teeth.

² Gervais, 'Ann. Sci. Nat.,' *op. cit.*, pl. V., fig. 1.

The generic distinctness of *Arctotherium* is confirmed by the character of the femur, of which there is a specimen in the British Museum. This bone in the form of its 'head' and 'neck' is like the femur of *Ursus*, but is laterally expanded, as in *Hyænarcotus*; being on the whole intermediate between the two, but nearer to that of the former.

Generic distinctness.—From the comparisons given above there can be little doubt of the generic distinctness of *Hyænarcotus* from all the allied forms. In describing the Crag specimens Prof. Flower remarks¹ that "it is certainly very closely allied to the true bears, though in its dentition somewhat less specialized than the modern representatives of the group." The observations recorded above strongly confirm this relationship, through *Arctotherium*; but exhibit equally strongly, through *H. paleindicus* and *Dinocyon*, a marked affinity with the dogs. The writer is unable to agree with Prof. Flower in considering the dentition of *Hyænarcotus* as less specialized than that of *Ursus*; its much more markedly carnassial character being in his own opinion a character of greater specialization. The simply tuberculate molar dentition of *Ursus* approaches more nearly than that of any other carnivorous genus to the molars of the bunodont *Suina*, and since it has lately been shown² that there are some remarkable indications of affinity existing between certain extinct *Suina* (*Achenodon*) and the bear-like Carnivora, it is not impossible that this simple type of dentition may be a retention of, or a reversion to, an original primitive form.

In the following diagram it has been attempted to indicate in the most provisional manner the probable relationship of *Hyænarcotus* to allied Carnivora. The present extent of knowledge does not permit the construction of a complete genealogical tree, and it does not necessarily follow that the genera placed in the lower lines are the direct ancestors of those in the higher lines with which they are connected by vertical lines. The genera placed on the same horizontal line indicate that there is at present no indication of one being the direct descendant of another:—



¹ *Op. cit.*

² H. F. Osborn, "On *Achenodon*, an Eocene Bunodont." 'Contributions from E. M. Mus. of Geol. and Archæol. of Princeton College—Bulletin No. 3'—Princeton, U.S.A., May, 1883.

UNDETERMINED TOOTH.

In figure 4 of plate XXX. there is represented a canine tooth of a carnivore, obtained by Mr. W. T. Blanford from the Siwaliks of Pegu, British Burma. From its extreme straightness the specimen probably belongs to the lower jaw. The tooth is more cylindrical, and straighter than the canine of any known species of *Ursus*: in the former respect it comes nearer to *Hyenarctos*, but is distinct from any of the canine teeth described above. The specimen is insufficient even for generic determination. The antero-posterior diameter at the base of the crown is 0·84, and the transverse 0·82: the summit has been broken off, and the enamel chipped away in many places.

GROUP B: *CANINÆ*.

Genera classed in the group.—In the account of the family *Ursinæ*, in which the present group is included, it has been mentioned that no satisfactory distinction can be drawn between the fossil representatives of the bear-like and the dog-like animals; the genus *Dinocyon*, which is arbitrarily included in the former group, having fully as much affinity with the latter: the present group must, therefore, be regarded as a purely arbitrary one, framed for the convenience of working. It is equally probable that in the opposite direction the group shades imperceptibly into the *Viverrinæ*, though the complete chain is not yet known.

In regard to the existing wolves, jackals, foxes, etc., which may be collectively called dogs, forming the family *Canidæ* of recent zoology, Professor Huxley, in a recent memoir,¹ has shown that their dentition exhibits a remarkable progressive serial development, or specialization, in four directions;—*viz.*, *firstly*, in the relatively increasing size of the whole dentition to that of the skull; *secondly*, in the proportionate increased size of the carnassial teeth to the hinder cheek-teeth; *thirdly*, in the diminution in size, or disappearance, of the hinder true molars; and, *fourthly*, in the structure of the carnassials. In respect of the two first points² the following table, taken from the memoir cited, exhibits the proportionate length of the carnassial teeth to the basicranial axis (=100), and to the succeeding cheek-teeth in six species of *Canis*, *viz.*:—

	A.			B.		
	<i>C. zorda.</i>	<i>C. littoralis.</i>	<i>C. famelicus.</i>	<i>C. vulpes.</i>	<i>C. niloticus.</i>	<i>C. argentatus.</i>
Length of pm. ⁴	20·6	22·4	23·5	27·3	28·3	28·5
„ „ <u>m.1</u>	17·3	18·1	18·	19·4	19·4	20·5
„ „ <u>m.1</u>	24·	27·2	28·	30·5	31·1	34·4
„ „ <u>m.2</u>	14·	15·7	13·5	14·7	14·4	15·

¹ 'Pro. Zool. Soc.,' 1880, pp. 238-88.

² It is unnecessary for the purpose of the present memoir to give Professor Huxley's cranial characters of the alopecoid and thooid dogs, as these are very generally inapplicable to palæontological purposes: for this reason both are included in the genus *Canis*, and are not separated as *Vulpes* and *Canis*.

These measurements show in the first place that in group A the check-teeth are relatively smaller than in the group B, so that the one may be termed *microdont*, and the other *macrodont* forms; and they also show that while $\overline{pm.4}$, $\overline{m.1}$, and $\overline{m.1}$, $\overline{m.2}$ all become larger between *C. zerda* and *C. argentatus*, the increase is far greater on the part of $\overline{pm.4}$ than on that of $\overline{m.1}$, and of $\overline{m.1}$ than on that of $\overline{m.2}$.¹ (See woodcut figure 8). The following table, calculated from Professor Huxley's measurements, exhibits the proportionate length of $\overline{pm.4}$ to $\overline{m.1}$ ($=1.0$) in three species of microdents, and three of macrodents, viz.:—

<i>Canis zerda</i>	1.19	} microdents.
— <i>littoralis</i>	1.23	
— <i>azarae</i>	1.26	
— <i>argentatus</i>	1.39	} macrodents.
— <i>lupus</i>	1.4	
— <i>vulpes</i>	1.4	

As this relationship is more available for paleontological purposes than the relations of the teeth to the basicranial axis, it is proposed (as has been done with the mustelines and the bears) to term the forms with small carnassials *meionocreodonts*, and those with large carnassials *megalocephodonts*: it may be convenient to class with the latter all those forms in which the proportionate length of $\overline{pm.4}$ exceeds 1.34.

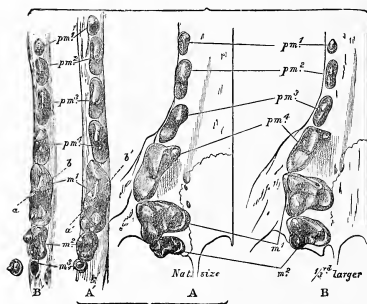


Fig. 8. The cheek-teeth of the recent *Canis argentatus* (A, A'), and *C. littoralis* (B, B'): the former $\frac{1}{2}$, the latter $\frac{2}{3}$;—this arrangement makes the length of $\overline{m.1}$ the same in both, and consequently exhibits well the megalocreodont character of the former and the meionocephodont character of the latter. a b, a' b' cusp-lines: $\overline{m.3}$ in B' was absent, and is figured from another specimen.

cheek-teeth is $\overline{pm.4}$, $\overline{m.1}$ ($\frac{2-1}{1-1}$), the dentition is microdont and meionocephodont, and the

The accompanying woodcut (fig. 8) exhibits the megalocreodont character of *C. argentatus*, and the accompanying diminution in size of $\overline{m.2}$, and $\overline{m.3}$.

Regarding the structure of the carnassials, in the genus *Canis*, in which the number of the cheek-teeth is normally $\overline{pm.4}$, $\overline{m.2}$,² and *Cyon* (*Cyon*), in which the true molars are $\frac{2}{3}$, the upper carnassial ($\overline{pm.4}$) consists of a distinct bilobed blade, with a relatively small tubercle (inner cusp) at its antero-internal angle. In *Otocyon*,³ in which the number of the

¹ Quoted with some alterations from Prof. Huxley's memoir.

² In *C. canis* the number is $\overline{pm.4}$, $\overline{m.2}$ ($\frac{2-1}{1-1}$); and M. Filhol (*op. cit.*) has shown that in the long-jawed domestic mees like the greyhound $\overline{m.2}$ is occasionally present, while in the short-jawed mees like the bull-dog $\overline{m.2}$ is sometimes absent.

³ Huxley, *op. cit.*, fig. 13.

inner tubercle of $\overline{\text{pm. 4}}$ is extremely large and bilobate, and placed more posteriorly than in *Canis*. This disposition is analogous to that prevailing in the generalized genus *Cynodictis*; and in conjunction with the presence of additional cheek-teeth,¹ the microdont dentition, and the small size of the carnassial, probably indicates that *Otocyon* is a survival of a primitive form of dog. On the opposite side of *Canis* to *Otocyon* is *Icticyon*² (considered by Prof. Huxley as subgenerically distinct from *Canis*), in which the number of the cheek-teeth is $\overline{\text{pm. 4}}$, $\overline{\text{m. } \frac{(4-2)}{2}}$; $\overline{\text{m. 2}}$ being either absent or very much reduced in size, and the inner cingulum of $\overline{\text{m. 1}}$ wanting: the carnassial ($\overline{\text{pm. 4}}$) is relatively large, with a proportionately small internal tubercle, and a distinct anterior talon ('accessory cusp' of Prof. Huxley), of which there is generally no trace in the true dogs.³ This talon is homologous to the anterior talon of $\overline{\text{pm. 4}}$ of *Hyænarcos* (pl. XXX. fig. 2: *a*), and its presence in *Icticyon* (the most specialized living dog) and its general absence in *Canis*, is precisely analogous to its presence in *Hyænarcos*, and its absence in *Ursus*.

The lower carnassial presents an analogous series of modifications:—thus in *Otocyon*⁴ the inner cusp of the blade is placed on the inner side of the hinder lobe of the same, which it nearly equals in size; and the line connecting the summits of the two (cusp-line) runs nearly at right angles to the long axis of the crown. In *Canis* (*woodcut fig. 8*) and *Cyon* the inner cusp becomes in the microdont forms (*B'*) reduced in size and placed behind the second lobe of the blade, causing the cusp-line (*a, b*) to become oblique; while in the macrodont forms (*A'*) these modifications become still more developed. In *Icticyon*,⁵ in which $\overline{\text{m. 3}}$ is absent and $\overline{\text{m. 2}}$ much reduced in size, the inner cusp of the blade has totally disappeared; and the hinder talon of the crown is much reduced and has lost its inner cusp, in consequence of which it becomes simply trenchant in place of cup-shaped.⁶ As has been previously noticed, the alteration in the size and position of the inner cusp of the blade from *Otocyon* to *Canis* is precisely similar to that which occurs from *Ursus* to *Hyænarcos*. The South African genus *Lycan* (*Hyænoides*), represented only by *L. pictus*, has the dentition of megalocrodon forms of *Canis*, but is distinguished by the absence of the pollex; though there is a rudiment of its metacarpal.

The foregoing observations show that among the existing dogs the specialization of the dentition is marked by the gradual reduction in the number and size of the hinder cheek-teeth, and in the increasing size, and advancing sectorial character of

¹ The author cannot agree with Prof. Huxley in regarding the occasional presence of $\overline{\text{m. 4}}$, and the presence of $\overline{\text{pm. 4}}$ in *Otocyon*, as indicative that the immediate ancestors of the group had $\overline{\text{m. 4}}$; as if such were the case, it is almost certain that some of the older canoids would show all these teeth. It is more probable that the presence of these teeth is a mere redundancy, perhaps caused, as M. Filhol supposes, by the length of the jaws. It is, however, unnecessary to apply this explanation, as is done by that writer, to the presence of $\overline{\text{m. 3}}$.

² Huxley, *op. cit.*, fig. 16.

³ As noticed by Prof. Huxley this talon occurs in *Canis bengalensis* and some other species.

⁴ Huxley, *op. cit.*, fig. 13.

⁵ *Ibid.*, fig. 16.

⁶ The writer is unable to accept the classification of the *Canida* proposed by Prof. Cope ('Bul. U. S. Geol. Surv.', vol. VI., p. 178), since the definition of *Icticyon* is "heel of inferior molar [carnassial] basin-shaped."

the carnassial teeth; and, what is most remarkable, that these variations are precisely analogous to those occurring in the arcoid genera *Ursus* and *Hyenarctos*. The latter fact must be considered to indicate that progressive development (as in some other instances) has taken place in different groups in parallel directions. The following formulæ show the reduction in the number of the cheek-teeth in the four above-mentioned canoid genera, viz.:—*Otocyon*, pm. $\frac{4}{4}$, m. $\frac{(3-4)}{4}$, *Canis*,¹ pm. $\frac{4}{4}$, m. $\frac{2}{3}$, *Cyon*, pm. $\frac{4}{4}$, m. $\frac{2}{2}$, *Icticyon*, pm. $\frac{4}{4}$, m. $\frac{1-2}{2}$. Turning to the fossil forms it will be found that it is quite impossible to arrange the genera under which these are classed in any regular taxonomic order, since some of them diverge in the direction of the bears, and others in that of the *Viverridæ*. It will, on the whole, be simpler to commence with the more generalized forms.

In *Cynodictis*, Pomel and Brav., of the Quercy phosphorites, the number of the cheek-teeth is pm. $\frac{4}{4}$, m. $\frac{2}{3}$, and the dentition is essentially microdont and meionocreodont: pm. 4 has its inner tubercle very large and placed sub-mesially: in $\overline{m.1}$ the inner cusp of the blade is also large and situated somewhat as in *Otocyon*, so that the cusp-line is transverse. Although this genus undoubtedly presents viverrine affinities, yet the form of pm. 4 is nearer to that of *Cephalogale*, and so is connected with the dog-like bears: the relatively large size of the second lobe of the blade of $\overline{m.1}$ is a canine rather than a viverrine character;—the two lobes being sub-equal in length in the latter group. The close resemblance of the skeleton of *Cynodictis* to that of *Amphicyon* has been pointed out by M. Filhol,² and Prof. Huxley³ notices a resemblance between the skull of the former and certain existing American *Canidæ*. Prof. Cope⁴ refers certain N. American fossil *Canidæ* to the genus *Galecynus*, Owen, but from the synonyms quoted, and from the statement that similar forms occur in the Quercy phosphorites, it is to be presumed that *Galecynus* is considered by Prof. Cope as equivalent to *Cynodictis*. Professor Huxley, however,⁵ sees no reason to generically distinguish the typical Eningen *Galecynus* from *Canis*; indicating that the former genus has no affinity with *Cynodictis*.

The genus *Cynodon*,⁶ Aymard, of the lower miocene of Europe, has the same dental formula as *Cynodictis*, and is equally microdont and meionocreodont; the tubercle of pm. 4 is, however, less developed, and placed more anteriorly than in the latter. In $\overline{m.1}$ the inner cusp of the blade is reduced in size and the talon very large; pm. 1 is very small and approximated to the canine, and the lower premolars are simple. In many of the points in which this genus differs from *Cynodictis* it approaches *Canis*, but the large size of the talon of $\overline{m.1}$ is a viverrine character.

In the allied genus *Amphicyonodon*,⁷ Filhol, in which the number of the cheek-teeth is the same as in the preceding, pm. 1 is very small, and all the premolars are

¹ *Canis* is taken to include *Vulpes*, *Urocyon*, Baird, and probably *Galecynus*; for palæontological purposes *Lycæon* may also be included with it.

² "Notes sur quelques Mammifères Fossiles, etc.," p. 97.

³ *op. cit.*, p. 281.

⁴ *op. cit.*, p. 180.

⁵ *op. cit.*, p. 280.

⁶ Filhol, "Mammifères Fossiles de Ronzon," pl. IX., figs. 40-41.,

⁷ *Ibid.*, pl. VIII., figs. 25, 29.

closely approximated: $\overline{\text{pm.2}}$ and $\overline{\text{pm.3}}$ are more trenchant and compressed than in *Cynodictis*, and the former has no talons: all the premolars are more elongated than in *Cynodon*. The upper carnassial has a well-developed inner tubercle; placed more anteriorly than in *Cynodictis*, and more distinct than in *Cynodon*. The true molars are larger than in the latter, and resemble those of *Cynodictis*. The ascending ramus of the mandible is extremely different from that of *Cynodon* and *Cynodictis*, and is said to resemble that of *Iutra*: $\overline{\text{m.1}}$ has a much shorter tubercular portion: $\overline{\text{pm.4}}$ has a hind talon-cusp, but is less complex than in *Canis*.

The genus *Amphicyon*,¹ Lartet, is distinguished from all its allies, except *Otocyon*, by the presence of m.3 ; the number of the cheek-teeth being $\overline{\text{pm.4}}$, m.3 : $\overline{\text{m.3}}$ is, however, normally small, and M. Filhol has shown² that in one species (*A. ambiguus*) this tooth is extremely minute, and occasionally absent. The presence of this tooth probably indicates that the dogs and bears originally descended from a stock in which the full number of the eutheroid dentition was present. In noticing this genus Prof. Huxley³ remarks that "in the shortness of $\overline{\text{pm.4}}$ relatively to $\overline{\text{m.1}}$, the large size of $\overline{\text{m.2}}$ relatively to $\overline{\text{m.1}}$, and of $\overline{\text{m.2}}$ relatively to $\overline{\text{m.1}}$, the dentition of *Amphicyon* repeats the general characters of that of *Cynodictis*." In certain specimens of *A. ambiguus*, however,⁴ $\overline{\text{pm.4}}$ is relatively much longer in proportion to $\overline{\text{m.1}}$ than in the latter genus—the proportions in the individual referred to being 1.4: 1.0; indicating a megaloceredont character. From measurements given by M. Filhol⁵ it appears, however, that megaloceredontism may exist with meionoceredontism in different individuals referred to the same species; apparently indicating that certain individuals had attained in this respect a specialization as great as that of the most specialized modern dogs; while others (*A. lemanensis*)⁶ had not advanced beyond the *Cynodictis* stage. The upper carnassial is very like that of *Canis*, but has a larger, though similarly placed, external tubercle: the inner cusp of the blade of $\overline{\text{m.1}}$ is larger than in *Canis*, and the 'cusp-line' less oblique: the upper true molars are intermediate between those of *Cynodictis* and *Canis*, but on the whole nearer those of the latter. The ursoid characters of the limbs and some parts of the skulls have been already alluded to. On the whole *Amphicyon* appears to be a generalized genus, somewhat more advanced in the direction of the bears and modern dogs than *Cynodictis*, and of which some species had attained a considerable dental specialization.

From *Amphicyon* and *Cynodictis* the transition is very gradual to *Cephalogale* and *Dinocyon*, the latter of which, as previously mentioned,⁷ cannot be distinguished by any characters of more than generic value from the hyænaretoid bears. In the former⁸ the number of the cheek-teeth is the same as in *Canis*: the earlier premolars have simple compressed crowns: $\overline{\text{m.1}}$ has the inner cusp of the blade small, but the

¹ *Pseudocyon*, Lartet, *Cynelos*, Jourdan, *Agnotherium*, Kaup.

² "Notes sur quelques Mammifères Fossiles, etc.," p. 76.

³ Filhol, "Phosphorites du Quercy," figs. 23-6 (*A. ambiguus*).

⁴ "Notes sur quelques Mammifères, Foss., etc.," p. 26.

⁵ Filhol, "Notes sur quelques Mam. Foss., etc.," pl. II.

³ *op. cit.*, p. 282.

⁴ Misprinted $\overline{\text{pm.4}}$.

⁷ *Ibid.*, pl. I.

⁸ *Vide*, p. 202.

hind talon large: $\overline{pm.4}$ has its internal tubercle large, and placed further back than in *Canis*, thus indicating affinity with *Dinoceyon hemiceyon*: $\overline{m.2}$ is relatively large: $\overline{m.1}$ is almost exactly like that of *Canis*. The base of the skull and the limb-bones present considerable resemblances to those of *Amphiceyon*.

The genus *Vulpavus* has been formed by Prof. Marsh¹ on the evidence of some upper molars from the eocene of Wyoming: these teeth are said to differ from those of existing foxes, by their relatively larger transverse diameter.

Of the remaining genera, *Brachyceyon*,² Filhol, from the Quercy phosphorites, is a meionocreodont form, only known by the mandible, and distinguished by the absence of $\overline{pm.1}$; the number of the lower cheek-teeth being $Pm. \overline{3}$, $M. \overline{3}$. It is considered to be closely allied to *Amphiceyon*.

Temnoceyon,³ Cope, from the miocene of North America, has $Pm. \frac{4}{3}$, $M. \frac{2}{3}$: this genus is said to be distinguished from *Canis* by the hind talon of $\overline{m.1}$ being trenchant, in place of cup-shaped, and by the presence of an epitrochlear foramen to the humerus: in the former character it agrees with *Icticeyon*, and in the latter with *Amphiceyon* and the bears.⁴

Enhydroceyon,⁵ Cope, from the same formation is distinguished from *Temnoceyon* by the absence of the first premolars, and perhaps of $\overline{m.3}$; the formula of the cheek-teeth being $Pm. \frac{3}{3}$, $M. \frac{2}{2(1)}$: it agrees with *Temnoceyon* in the trenchant form of the hind talon of $\overline{m.1}$.

In *Hyanoceyon*,⁶ Cope, also from the miocene of North America, the formula of the cheek-teeth is $Pm. \frac{4}{3}$, $M. \frac{1}{1(1)}$. It is somewhat doubtful if this genus belongs to the *Caninae*; if it does, its dentition is numerically more specialized than that of any other genus; *Icticeyon* coming nearest in this respect.

Palaocceyon,⁷ Lund, from the pleistocene of South America, has $Pm. \frac{4}{3}$, $M. \frac{2}{3}$, and agrees with *Icticeyon* in the absence of the tubercle of $\overline{pm.4}$, and the inner cusp of the blade of $\overline{m.1}$: it appears to be megalocreodont.

Speothos, Lund, of the same deposits, is considered by Prof. Huxley⁸ to be probably the same as *Icticeyon*.

Lycorux,⁹ Bourget, is a megalocreodont wolf from the caverns of France, of which only the mandible and lower dentition are known: it agrees with *Enhydroceyon* and *Brachyceyon* in the suppression of $\overline{pm.1}$, the number of the lower cheek-teeth being $Pm. \overline{3}$, $M. \overline{3}$; but differs from the former in the cup-shaped talon of $\overline{m.1}$. In the opinion of the present writer the mere absence of $\overline{pm.1}$ is not sufficient to justify generic distinction from *Canis*.

¹ "American Journal of Science," 3rd ser., vol. II., p. 124. The genus *Dromoceyon*, Marsh (*Ibid.*), vol. XII., p. 403, is allied to *Hyænodon*.

² Filhol, "Phosphorites du Quercy," figs. 27-9.

³ Cope, *op. cit.*, p. 179.

⁴ M. Filhol ("Notes sur quelques Mammifères Fossiles, etc.," p. 82) quotes Prof. Cope to the effect that the ursine post-parietal foramen is present in this genus: in the passage quoted, however, the presence of this foramen is denied by Prof. Cope.

⁵ Cope, *op. cit.*, p. 178.

⁶ *Ibid.*, p. 181.

⁷ Huxley, *op. cit.*, pp. 279-80. *Palaocceyon*, Blain.=*Arctoceyon*.

⁸ *Ibid.*, p. 280.

⁹ Bourguignat, 'Ann. d. Sci. Geol.,' vol. VI., pl. XVIII.

The genus *Elocyon*, Aym., may perhaps be referred to the *Viverridae*. *Arctocyon*, Blain., is too imperfectly known for its position to be accurately determined; Prof. Cope makes it the type of a family of his order Creodonta. *Hemicyon*, Lartet, is provisionally referred to *Dinocyon*; and *Pseudocyon*, Lartet, to *Amphicyon*. *Hydrocyon*, Lartet, is said to have a dentition intermediate between that of the dogs and the otters.

GENUS I.: AMPHICYON,¹ Lartet.

Syn. *Agnotherium*, Kaup (*in parte*). *Cynelos*, Jourd. (?) *Pseudocyon*, Lartet.

Dentition.—As this genus is more nearly allied to the bears than *Canis*, it is placed first: many of its dental characters have already been mentioned, and it will, therefore, suffice to indicate in what respects the individual hinder cheek-teeth differ from those of *Canis*. According to M. Filhol,² pm. 3 may or may not have a posterior talon-cusp; the latter being present in all species of *Canis* except *C. palaeovulpecos*. In m. 1 the inner cusp of the blade is larger and placed more forward than in *Canis*, although some of the meionocreodont forms of the latter make a near approach in this respect: this tooth in *Amphicyon* is in fact intermediate between that of *Cynodictis* and *Canis*. In pm. 4 the inner tubercle is larger than in *Canis*, the whole tooth being intermediate between the carnassials of *Canis* and *Cynodictis*. The two last lower true molars are almost indistinguishable from those of *Canis*. In m. 1 the two outer lobes are generally placed more internally than in *Canis*, forming two isolated pyramids on the crown, instead of being continuous with the outer wall as in the latter: *A. ambiguus* is, however, intermediate in this respect: in typical species this tooth approaches *Cynodictis*. This tooth is also more developed transversely than in *Canis*; its cingulum embracing more of the inner half of the crown (though there is a certain amount of variation in this respect between different individuals of *C. lupus*): and the two inner tubercles, in place of being distinct as in *Canis*, united into a crescent placed internally to the cingulum.

Distribution.—According to Prof. Gaudry³ the earliest appearance of the genus in Europe is in the middle eocene (*étage des sables de Beauchamp*); and it survived till the middle miocene of Sansan. It is represented in the miocene of North America, and in the Siwaliks of India.

Number of species.—The following list comprizes the best determined of the named species, exclusive of the Siwalik form, which is described below. Owing to the confusion in the synonymy of the European species, it is possible that this list may not be in all respects perfectly correct.

1. AMPHICYON AMBIGUUS,⁴ Filhol. Quercy phosphorites.

M. 3 very small, and may be absent: pm. 4 sometimes very large: m. 1 more caninoid than in any other species: the species was about equal in size to *C. lupus*.

¹ The name *Amphicyon* was applied by Lartet in 1837 ('Compt. Rend.,' vol. V., p. 421), and that of *Agnotherium* by Kaup in 1833 ('Oss. foss. d. Musée d. Darmstadt'): the latter has, therefore, the priority, but the former has gained universal acceptance.

² "Notes sur quelques Mammifères Fossiles, etc.," pp. 78-81.

³ "Les Encheînements du Monde Animal, etc.—Mammifères Tertiaires," p. 4.

⁴ "Phosphorites du Quercy," figs. 22-6, 41-3.

2. AMPHICYON ANGUSTIDENS,¹ Marsh. Miocene, N. America.
Known only by a fragment of the mandible: equal in size to a small fox.
3. AMPHICYON BREVIROSTRIS² (Croiz.). Low. miocene, Clermont.
Canis brevirostris, Croiz. *Canis issiodorensis*, Blain.
Amphicyon issiodorensis, Blain.
Dentition considerably smaller than that represented in woodcut fig. 8, B (p. 241).
4. AMPHICYON CURTUM,³ Filhol. Quercy phosphorites.
5. AMPHICYON CUSPIDATUS,⁴ Cope. Miocene, N. America.
A small species, with teeth about the size of those of *A. vetus*.
6. AMPHICYON DOMINANS,⁵ Myr. Miocene, Europe.
A rather small, and apparently undescribed, species.
7. AMPHICYON ENTOPYCHUS,⁶ Cope. Miocene, N. America.
About equal in size to the American kit fox (*Canis [Vulpes] fulvus*).
8. AMPHICYON ESERI,⁷ Plén. Miocene, Europe.
An imperfectly known species.
9. AMPHICYON GIGANTEUS,⁸ Laur. Miocene, France.
A very large species of which only $\frac{m.1}{m.1}$ and a canine are known: the transverse diameter of the former is 1.5 inches: the species is considered by De Blainville as probably identical with *A. major*.
10. AMPHICYON HARTSHORNIANUS,⁹ Cope. Miocene, N. America.
About the size of the coyote (*Canis ochropus*); with the molars relatively small.
11. AMPHICYON HELVETICUS,¹⁰ Pictet and Humbert. Miocene, Switzerland.
A provisional species, with teeth considerably smaller than those of the wolf; is said to present certain resemblances to *Hyænodon*.
12. AMPHICYON INTERMEDIUS,¹¹ Myr. Mid. miocene, Europe.
A large species, with a trenchant outer cusp to the talon of $\frac{m.1}{m.1}$, and the premolars very small and widely separated.
13. AMPHICYON LEMANENSIS,¹² Pomel. Miocene, France.
A. blainvilliei, Gerv. *A. leptorhynchus*, Pomel.
A. elaverensis, Gerv. *A. minor*, Blain (*in parte*).
A. gracilis, Pomel. *Cynelos langensis*, Jourd.
A microdont and meionocreonid species, with a skull about the size of that of the wolf.

¹ 'Amer. Journ.', 3rd ser., vol. II., p. 124.

² Blainville, "Ostéographie," Gen. *Canis*. pl. XIII.

³ 'Comptes Rendus,' vol. XCI., p. 344. The writer has had no opportunity of seeing this notice.

⁴ 'Bul. U. S. Geol. Surv.,' vol. VI., p. 178.

⁵ 'N. Jahrb.,' 1843, p. 388: according to Peters ('*Denks. k. Ac. Wissensch. Wien*,' math. nat. Cl., vol. XXIX., 1869, p. 191), the species is only known by this preliminary notice.

⁶ 'Pro. Am. Phil. Soc.,' vol. XVIII., p. 371.

⁷ 'Würtemb., Jahreshb.,' vol. V., p. 216, pl. I.

⁸ Blainville, "Ostéographie," Gen. *Subversus*, pl. XIV. (*A. d'Avary*).

⁹ 'Bul. U. S. Geol. Surv.,' *op. cit.*

¹⁰ Pictet, "Paléontologie Suisse," vol. V., p. 135.

¹¹ Suess, "Über *Amphicyon intermedius* von Tachoric in Böhmen" ('*Sitz. k. Ac. Wissensch. Wien*,' vol. XLIII., p. 224): and Peters ("Zur Kenntniss der Wirbelthiere aus den Mioceenschichten von Eisbühlwald")—'*Denks. k. Ac. Wissensch. Wien*,' math. nat. Cl., vol. XXIX., 1869, p. 190, pl. III.

¹² Filhol, "Notes sur quelques Mam. Foss. etc.," p. 2, pl. I.

14. AMPHICYON MAJOR,¹ Blain. Mid. miocene, Sansan.
A. crassidens, Pom. *A. minor*, Blain (*in parte*).
A. laurillardi, Pom. (?) *Pseudocyon sansaniensis*, Lart.
 A species of which some specimens are as large as a brown bear.
15. AMPHICYON VETUS,² Leidy. Miocene, North America.
 A species rather smaller than *Canis latrans*: $\frac{m}{n}$ 3 very small.
16. AMPHICYON ZIBETHOIDES³ (Blain.). Mid. miocene, Sansan.
Viverra zibethoides, Blain.
 A small species, of which the generic determination is somewhat uncertain.

From the miocene of N. America Prof. Leidy has described⁴ a small species under the name of *A. gracilis*: the name had, however, been previously applied by Pomel to one of the European species (*A. lemanensis*), and should, therefore, be changed. The species is smaller than *Canis bengalensis*, and its lower carnassial is remarkably like that of *Cynodictis*. There also occur the following specific names, viz., *A. agnotus*, Pom. (*Agnotherium antiquum*, Kaup, *in parte*); *A. communis*, Myr.; *A. crucians*, and *A. cultridens*, Laur. It is stated⁵ that *Canis ursinus*, and *C. haydeni*, Cope,⁶ may possibly belong to *Amphicyon*. The so-called *A. diaphorus* (Kaup) is the same as *Metarctos*.

Species: AMPHICYON PALÆINDICUS, nobis.

History.—In the first volume of this work⁷ an upper true molar and a part of the mandible with $\frac{m}{n}$ 4 and $\frac{m}{n}$ 1 of a canoid animal were described and figured under the above name; some doubt being entertained whether the two belonged to the same species. As the figures were drawn by an incompetent native artist it has been thought better to reproduce them; their description being at the same time more fully given.

Upper true molar.—The above-mentioned upper true molar is represented of the natural size from the grinding surface in figure 8 of plate XXXII. It was obtained from the Siwaliks of Kúshalghar, on the Indus, some twenty miles below Attock, by Messrs. Garnett and Trotter, who presented it to the late Dr. Oldham. By him it was submitted to Dr. Falconer, who made a manuscript note upon it, subsequently

¹ Blainville, "Ostéographie," Gen. *Subursus*, pls. XIV.-V. Gaudry, "Les Enchainements, etc.," fig. 277. Pomel ("Cat. Math. Vert. Foss.," p. 72) divided Blainville's *A. major*, from Sansan, into the two species *A. laurillardi* and *A. crassidens*: as, however, he did not give figures or clear definitions it is better, with Prof. Peters, to retain all the specimens figured by Blainville, under the name of *A. major*, which has the priority over Pomel's names: the Sansan specimens indicate, however, a large and a small race. The lower jaw from Monte-Bamboli figured by Meneghini under the name of *A. laurillardi* ('Atti. Soc. Ital. Sci. Nat.,' vol. IV., pl. IIa) has been referred by Gervais ('Zool. et Pal. Generales,' ser. 2, 1875, p. 22) to a new species of *Hyenarctos*; a fact with which the present writer was unacquainted, when describing that genus. Pomel referred *Pseudocyon sansaniensis*, Lart., to his *A. laurillardi*; a reference which is provisionally followed here.

² Leidy, "Extinct Mammalian Fauna of Dakota and Nebraska," p. 32, pl. I.

³ Blainville, "Ostéographie," Gen. *Viverra*, pl. XIII.—Gervais, "Zoologie et Paléontologie Françaises," pl. XXXVII, fig. 13.

⁴ Leidy, *op. cit.*, pls. I. and V.

⁵ Bul. U. S. Geol. Surv., vol. VI., p. 178.

⁶ 'Rep. U. S. Geog. Surv. W. of 100th Meridian, vol. IV., pt. 2, p. 304, pl. LXIX. 7 P. 84, pl. VII., figs. 5, 8, 12.

published in the "Palæontological Memoirs," to the following effect:—" *Amphicyon*. —The specimen is the tubercular tooth of a large carnivorous animal, as large as the polar bear and allied to the *Amphicyon*. . . ." When the specimen came into the present writer's hands in 1875 it had a label attached bearing the name *Amphicyon palæindicus*, in Dr. Falconer's handwriting. The tooth belongs to the right side of the skull of a canoid animal; and from the small size of the second outer cusp it is probably the second true molar. The grinding surface of the crown carries on its outer side (*top of figure*) two conical cusps, of which the foremost (*right of figure*) is about twice the size of the hinder: there is a distinct cingulum at the base of these cusps, which in its regular form and distinctness agrees with *Amphicyon*. On the inner side of the tooth there is a very large and broad cingulum, embracing the whole of the inner half of the crown; also agreeing with the tooth of *Amphicyon*. Within this cingulum there is a smaller crescent, culminating in one large median cusp; the presence of which distinguishes the tooth from m.1 of *Canis*, in which there are two inner cusps. The surface separating the inner cusp from the outer cusps is nearly flat, and not bounded by ridges antero-posteriorly. The proportionate excess of the transverse over the antero-posterior diameter is greater than in *Canis*, and similar to that prevailing in typical species of *Amphicyon*. In the following table the dimensions of the specimen are compared with the corresponding dimensions of m.2 of *A. major*, viz.:—

	<i>A. palæindicus.</i>	<i>A. major.</i>
Greatest antero-posterior diameter	0·76	0·87
" transverse "	1·12	1·3
Height of antero-external cusp	0·4	0·52

Although it is impossible to determine the number of molar teeth in the animal to which the specimen belonged, yet the resemblance of the tooth to the molars of *Amphicyon* is so strong that there is every probability that it belonged to that genus. The size of the tooth indicates an animal far larger than the wolf, showing that the only species in the foregoing list with which it can be compared in this respect, are *A. giganteus*, *A. major*, and *A. intermedius*.² From the first (assuming that species to be distinct from *A. major*) the specimen is sufficiently distinguished by its much smaller size. From the second³ it is distinguished by the transverse being proportionately greater than the antero-posterior diameter, and by the inner cingulum being broader and flatter, and the inner crescent much less distinctly marked: this part in the European species not being differentiated into any distinct cusp: the surface between the inner crescent and the outer cusps in the latter is distinctly hollowed, and bounded antero-posteriorly by the crescent. The writer has not had an opportunity of comparing the upper molars of *A. intermedius* with the Indian tooth, but as it will be shown that the lower carnassial of that species is distinct from the corresponding tooth provisionally referred to the present species, it may be inferred, if this reference be correct, that the upper molars of the two forms would be distinct. In

¹ Vol. I., p. 416.

² Unless *A. curtum* be a large species.

³ The larger specimens figured by Blainville are taken as the type.

the small European *A. dominans*¹ the form of the inner crescent is nearly intermediate between the present specimen and *A. major*.

Lower carnassial.—In figures 5, 5a, of plate XXXII. there is represented the above-mentioned fragment of the mandible, containing the last milk-molar (mm. 4) and the permanent carnassial (m. 1), which was obtained by Mr. H. B. Medlicott from the Siwaliks of Núrpur. The specimen belongs to the right side, and the permanent carnassial is untouched by wear, and could only have been slightly protruded above the level of the gum at the death of the animal. The deciduous and permanent carnassials are, except in the matter of size, perfect replicas of one another, and it will therefore suffice to describe the larger tooth.

The proper 'blade' of this tooth consists of the two normal outer lobes (*a*, *b*), resembling the corresponding parts of the tooth of *Canis* and *Amphicyon*: the inner cusp of the blade (*x*) is relatively small and placed considerably behind the second lobe of the blade (*b*), causing the 'cusp-line' to be extremely oblique. In these respects the tooth agrees with the megalocreodont species of *Canis* (fig. 8, *A'*, p. 241), and differs from the typical species of *Amphicyon*, in which the inner cusp is relatively larger, and placed more nearly opposite the centre of the second main lobe of the blade.² In the hinder, or talon, portion of the tooth the specimen differs both from *Canis* and typical species of *Amphicyon*. The outer cusp of this portion (*c*) in place of being equal in size to, or rather larger than the inner, and with it enclosing a distinct hollow, is very much larger, being rather higher than the first lobe of the blade (*a*). The edge of this cusp is trechant antero-posteriorly, and forms in point of fact a distinct third lobe to the blade, making the cutting power of the tooth much greater than in *Canis* and typical species of *Amphicyon*. The inner cusp of the talon (*right side of c*, fig. 5) is small but distinct. In the following table the dimensions of the specimen are compared with those of the large race of *A. major*, viz.:

	Specimen.	<i>A. major</i> .
Length of mm. 4	0.74	
" " m. 1	1.32	1.2
Width " " posteriorly	0.6	0.5
Height of second lobe of blade of ditto	0.89	0.7
Depth of jaw at ditto	1.57	1.93

These dimensions show that the tooth is larger than the lower carnassial of *A. major*, and since it has been shown that the upper molar of *A. paleindicus* is smaller than the corresponding tooth of that species, it may be inferred, if the present specimen belong to the same species, that the latter had a more *megalocreodont* character than the European species.

In *A. intermedius*, according to the specimens figured by the late Prof. Peters,³ the characters, of the talon of $\overline{m.1}$ are precisely similar to those of the same tooth in the Núrpur specimen. In the European species, however, $\overline{m.1}$ is considerably

¹ Compared with specimens in the Indian Museum from Weissenau, so named by Prof. Klapstein.

² See Filhol, "Notes sur Mam. Foss., etc.," pl. I., fig. 2, and "Phosphorites du Quercy," figs. 22, 25, 41, 43.

³ *Op. cit.*, pl. III., figs. 1-3.

wider: and the hind outer lobe of the blade, and the outer cusp of the talon, form more regular cones; while the inner lobe of the blade is larger; and the depth of the jaw proportionately greater. There is, therefore, no doubt that the two forms are specifically distinct, although closely allied. Both species evidently indicate a transition from typical forms of *Amphicyon* in the direction of *Icticyon* and *Temnocyon*; in the second of which the inner cusp of the talon has disappeared, while the former has lost the inner cusp of the blade, though the outer cusp of the talon is not so large as in the present specimen. According to Prof. Peters the smaller race of *A. major* approaches much nearer to *A. intermedius* than does the larger race, so that there are some indications of a transition between the two. The so-called *Canis ursinus*, Cope, which may belong to the present genus, is distinguished by its greater depth of jaw and shorter $\overline{m.1}$; but is too much damaged for further comparison.

Conclusions.—Seeing that the upper molar described above agrees very closely with the corresponding tooth of *Amphicyon*, and that the lower carnassial, which in respect of size may well belong to the same species, also agrees with $\overline{m.1}$ of a somewhat aberrant form of the same genus, there is a great probability that the two should be referred to the same species.¹ Adopting this provisional reference, the species will differ from other species of *Amphicyon*, with the exception of *A. intermedius*, by its more megaloceredont character, and the greater specialization in the structure of $\overline{m.1}$: and it will be apparent that *A. palaeindicus*² and *A. intermedius* are more specialized in the structure of their lower carnassials than any other known members of the genus; the specialization being so great that they could not have been on the direct ancestral line either of *Canis* or the hyænarctoid bears; although it is possible that they may be more intimately related to *Temnocyon*.³ Two fragmentary lower carnassials precisely similar to the Nûrpûr tooth have been obtained by Mr. W. T. Blanford from the lower Siwaliks of Sind, and are now in the Indian Museum (No. D. 24).

Second lower true molar.—In figure 4 of plate XXXII. there is represented, from the masticating surface, a fragment of the mandible of a carnivore obtained by Mr. F. Fedden from the lower Siwaliks of Sind, and briefly alluded to in the "Records"⁴ under the name of *A. palaeindicus*. This specimen belongs to the right ramus of the mandible, and shows $\overline{m.2}$ and the alveolus of $\overline{m.3}$: it is broken inferiorly, so that the depth of the jaw cannot be ascertained. The antero-external and the postero-internal angles of the one remaining tooth have been broken away; but this tooth is otherwise perfect, and untouched by wear. It closely resembles the corresponding tooth of *Canis* and *Amphicyon*, and from its size may probably be referred to the latter genus; and may very possibly belong to *A. palaeindicus*. The alveolus of $\overline{m.3}$

¹ In the former notice of these specimens the writer considered that the larger proportionate size of $\overline{m.1}$ might indicate specific distinction: he was at the time unacquainted with the progressive development in the relative size of the carnassials of the dogs.

² These conclusions will be equally valid if the lower carnassial should eventually be proved specifically distinct from the upper molar.

³ The writer is not aware of the existence of a figure of the dentition of this form.

⁴ Vol. XI., p. 102.

indicates that this tooth was elongated antero-posteriorly and inserted by two fangs. In all species of *Canis*, and apparently in all other species of *Amphicyon*, (e.g., *A. major*, *A. ambiguus*, *A. lemanensis*), $\overline{m}.3$ has a sub-circular crown and is inserted by a single fang. The present specimen probably indicates affinity with an older form in which $\overline{m}.3$ was fully developed; and is not so specialized as the lower carnassial described above. The length of $\overline{m}.2$ is 0.79, and its greatest width 0.56 inch.

Distribution.—Assuming that the specimens described above are rightly associated, the range of the species extended from the Kangra district to Sind. The Sind specimens come from the lower Siwaliks, and from the presence of low beds (Náhan group) in the neighbourhood of Núrpúr, it is not impossible that the specimen from that district may have been derived from that horizon. The Kúshalghar specimen came from beds which have yielded *Dinotherium*, and may, therefore, equally well be low in the series. It is noteworthy that the European species which comes nearest to the Indian form occurs in Bohemia and Styria, on the eastern side of Europe.

GENUS II.: CANIS, Linn.

Including *Vulpes*, *Lupus*, *Urocyon*, etc.

Distribution.—The dentition of the genus has already been sufficiently alluded to in earlier paragraphs; and it has been noticed that forms like *Lyceus* should not probably be included within it; it may be further observed that in many instances it would be impossible to determine whether fossil remains of dogs belonged to *Canis* or to *Cyon*. With regard to the number of species, the uncertainty as to the validity of specific characters, and the host of forms that have received distinct specific appellations renders it almost impossible to give anything like a correct list of the existing, let alone of the fossil, forms. As to the date of the earliest appearance of the genus there is still considerable uncertainty. From the upper eocene of Paris an incomplete mandible of a canoid animal, with but a single tooth remaining, has been described under the name of *Canis parisiensis*,¹ Laur.; it is, however, extremely doubtful whether this determination is generically correct. From the phosphorites of Quercy another mandible has been referred to the same genus under the name of *C. paleolyceus*, Gerv.²; but is stated to present strong affinity to *Amphicyon*. Two other species have also been described from the same deposits under the names of *C. filholi*,³ and *C. cadurcensis*.⁴ The former is characterized by the very large size of the inner cusp of the blade of $\overline{m}.1$, from which M. Filhol considers it extremely improbable that the species is a true *Canis*. The latter, though more like *Canis*, is considered by the same writer to be nearer *Cynodictis*: before, however, this can be certainly determined, it is necessary that the upper dentition should be known. These observations indicate that whether the four above-mentioned species should be referred to *Canis*, or to other genera, it is quite clear that they differ very considerably

¹ Gervais, "Zoologie et Paléontologie Françaises," 2nd ed., p. 213.

² Filhol, "Phosphorites du Quercy," p. 53.

³ *Ibid.*, p. 539, figs. 123-4.

⁴ *Ibid.*, loc. cit., figs. 44-5.

from the modern representatives of the genus; indicating that typical dogs did not exist in Europe in the period of the upper eocene. From the lower and middle miocene of Europe there are apparently no described species of true *Canis*,¹ but the so-called *Galecyne* of the upper miocene, or lower pliocene, of Eningen is considered by Prof. Huxley² to be not improbably generically identical with *Canis*.³ In N. America, according to Prof. Cope,⁴ the dogs "of the lower miocene and middle miocene epochs belong to genera allied to, but distinct from, *Canis*, while those of the upper miocene (Loup Fork) and later horizons, pertain to the latter genus with few exceptions."⁵ From the eocene of Wyoming Prof. Marsh⁶ has, however, described a species of dog under the name of *Canis montanus*⁷; but since the species is described solely on the evidence of an upper premolar and a canine, it is impossible to say whether the generic determination is correct. From the upper pliocene of France there is the *Canis borbonicus*, Brav.,⁸ considered by Prof. Huxley⁹ to be closely allied to the meiocenecodont *C. cancrivorus* of South America. From the pliocene of the Val d'Arno, Italy, two species have been described by Prof. Forsyth-Major¹⁰ under the names of *C. etruscus* and *C. falconeri*: while in the pleistocene there are numerous species, and races, which need no further allusion.

It thus appears that undoubted species of *Canis* are not known to have existed in Europe before the upper miocene or lower pliocene, and in N. America before the upper miocene period: and it may be added that the genus probably attained its maximum in the pleistocene and recent periods.

Species 1: *CANIS CURVIPALATUS*, Bose.

History.—In the year 1836 Messrs. Baker and Durand briefly described and figured¹¹ the skull and associated mandible of a small canoid animal to which they did not assign any specific name, although it was provisionally alluded to as *Canis vulpes* (?). Their description has been quoted in the "Palæontological Memoirs,"¹² The two specimens subsequently came into the possession of the British Museum, and in 1880 were redescribed somewhat more fully by Mr. P. N. Bose,¹³ who assigned them to a new species, under the name of *Canis curvipalatus*. As the original figures are small and unsatisfactory, and the specimens are not figured by Mr. Bose, they have been refigured in the present memoir, and will now be described.

1 The so-called *Canis lemanensis*, *C. leptorhynchus*, *C. crassidens*, etc., belong to *Amphicyon*.

2 'Pro. Zool. Soc.,' 1880, p. 280.

3 The genus *Galecyne*, as mentioned above, is employed by Prof. Cope in a wider sense, embracing *Cynodictis*.

4 'Bul. U. S. Geol. Surv.,' vol. VI., pp. 177-8.

5 For a list of American fossil *Canidae* see Cope, "Rep. U. S. Geog. Surv. W. of 100th Meridian," vol. IV., pt. 2, p. 301.

6 'American Journal of Science,' 3rd ser., vol. II., p. 123.

7 The name *montanus* should be changed, as it has long since been applied to the Himalayan Fox (*Canis* [*Vulpes*] *montanus*, Pearson).

8 Gerv., "Zoologie et Paléontologie Françaises," pl. XXVII., fig. 7.

9 *Op. cit.*

10 'Atti. Soc. Tosc. Sci. Nat.,' vol. III., p. 208, pls. XIII.-IV.

11 'Journ. As. Soc. Beng.,' vol. V., pl. XXVII., figs. 9-12.

12 Vol. I., p. 341.

13 'Quart. Journ. Geol. Soc.,' vol. XXXVI., pp. 134-6. This paper was read in December, 1879.

Cranium.—The above-mentioned cranium, represented of the natural size in figures 1, 1a, of plate XXXII., is deficient only in the zygomatic arches, and in the extremity of the muzzle. Mr. Bose observes that it has “suffered from a crush, and has, in consequence, been somewhat flattened anteriorly; but no distortion, at least to any considerable extent, has taken place.” The same writer also observes that Messrs. Baker and Durand, after comparing it with a skull of *Canis bengalensis* (Bengal fox), “found that the fossil, while agreeing generally with the latter, differed from it in the greater breadth of the brain-case, the height and thickness of the lambdoidal crest at the summit of the supra-occipital, the greater concavity and size of the post-orbital processes of the frontal, and the closer approximation of the false-molars in the upper jaw; but they did not notice the following important peculiarities of the fossil, nor did they give it any specific name:—

“In all *Canidae*, and more or less in all other Carnivora, the basifacial axis is parallel to the basicranial axis; but in the fossil now under examination the palate makes an angle, though a very open one, with the base of the cranium, somewhat as in the rabbit. The specific name is derived from this the most characteristic feature of the fossil.

“The internal tubercle of the sectorial is stouter than in the [Bengal] fox.

“The upper tuberculars, especially the hindmost one, are proportionately larger.

“Messrs. Baker and Durand noticed a peculiarity about the frontal ridges, that these, starting from the rear of the post-orbital apophyses, “converge towards the occiput in a curvilinear direction, until the distance between them is reduced to about half an inch, after which they run nearly parallel for some distance, and then converge again, till they unite near the occiput, and become blended with the parietal crest. I find this peculiarity, which is absent in the European fox, well marked in both the specimens of the Bengal fox (*Canis bengalensis*) I have had for comparison, as well as in the Fennecs [*C. zerda*, *C. caama*].”

As the skull of *Canis (Vulpes) bengalensis* agrees very nearly in general size with the fossil skull it will be convenient to institute a somewhat closer comparison between the two. It may be premised that the living species is a microdont and meionoceredont form, having the carnassial teeth rather larger than certain North American alopecoids, such as *Canis littoralis* (woodcut fig. 9, B, p. 256), considered by Prof. Huxley¹ as the nearest living allies of *Otocyon*; and connecting that group, through the small S. African alopecoids *C. zerda* and *C. caama*, with the larger megaloceredont foxes of the Old World, such as *C. vulpes*. It will be seen from the woodcut cited that the last true molars in these meionoceredont alopecoids is relatively much larger than in the megaloceredont forms; indicative in all probability of their affinity with *Otocyon*, in which all the three true molars are present; the second of the series being relatively large.

¹ *Op. cit.*, p. 267.

That the fossil skull belonged to a fully adult individual is indicated by the fact that the true molars have been considerably worn down. Curiously enough the hinder cheek-teeth are slightly unequal in size on the two sides of the skull: in the following table, in which the dimensions of the specimen are compared with those of an adult skull of *Canis bengalensis* in the author's collection, the teeth of the left side are measured. The respective dimensions of the two skulls are as follows, viz.:

	<i>C. curvipalatus.</i>	<i>C. bengalensis.</i>
Length from hinder border of basiophenoid to hinder border of canine . . .	3.44	3.68
Width of palate at m. 1	1.23	1.3
" " " " pm. 1.	0.66	0.6
Interval between carnassial and canine	0.7	0.86
Zygomatic width at post-orbital process	2.121	2.2
Width across post-orbital processes	1.13	1.1
" of brain-case	1.67	1.62
Length of pm. 2	0.22	0.26
" " " 3	0.24	0.31
" " " 4	0.35	0.43
" m. 1	0.36	0.37
" " 2	0.27	0.25

On the right side the length of pm. 4 is 0.38 and that of m. 1 0.33.

It will be seen from these dimensions that the fossil differs from the recent skull in having the anterior part of the palate proportionately shorter and wider. In this respect it agrees more nearly with the Californian *Canis littoralis* (of which the upper dentition is represented on the next page), and *Otocyon*.² In *Canis bengalensis* the proportionate length of pm. 4 to m. 1 is as 1 to 1.16 in the specimen of which the measurements are given here, and as 1 to 1.18 in the specimen measured by Prof. Huxley. In the fossil skull on the left side pm. 4 is shorter than m. 1, and on the right side the proportion is 1 to 1.11. This gives the remarkable fact that while on the right side the proportionate length of these teeth is very nearly the same in the two forms; yet on the opposite side the proportion is about the same as in *Otocyon*, in which alone among all existing *Canine* pm. 4 is shorter than m. 1. The structure of the former tooth is, however, that of *Canis*; although, as Mr. Bose mentions, the inner tubercle is relatively larger than in *C. bengalensis*; a feature indicative of generalized affinities. There is no trace in the fossil of the minute anterior talon to the blade of pm. 4 existing in the living species.

Coming to the true molars, it will be seen from the table of measurements that while m. 1 is slightly smaller in the fossil than in the recent form, m. 2 is considerably larger. From a comparison of the figures of the fossil and the upper dentition of *C. littoralis* in the woodcut on the next page (fig. 9), which is so close to that of *C. bengalensis* that it will answer the same purpose,³ it will be noticed that while in the latter the lines forming the outer borders of the carnassial on the one hand, and

¹ Obtained by taking twice the length of the left side.

² Huxley, *op. cit.*, fig. 11, p. 257.

³ It should be remembered that the teeth of *C. littoralis* are drawn $\frac{1}{2}$ larger than the natural size; and that they are viewed from the opposite direction to that from which the other figures are taken.

of the two true molars on the other, form a very marked angle with one another,

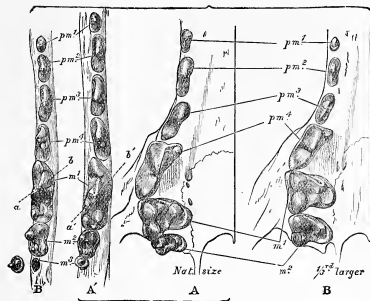


Fig. 9. The cheek-teeth of *Canis argentatus* (A, A'), and *C. littoralis* (B, B'). The former $\frac{1}{2}$; the latter $\frac{1}{4}$. The former is a megalocercodont, and the latter a meionocercodont alopecoid.—Recent, N. America.

same as in *C. littoralis*. In *Otocyon*,² however, the outer border of the true molars runs parallel to the median palatine axis, while *pm. 4* is also set parallel to the same line, though somewhat internally to the outer line of the molars. It thus appears that in the characters of the hinder cheek-teeth the fossil skull presents certain characters intermediate between the smaller alopecoids and *Otocyon*, although in the proportionate size of these teeth to the skull it is considerably nearer the former. On the right side of the specimen the alopecoid characters are more clearly marked.

In regard to the earlier premolars, the table of measurements will show that these are much smaller in the fossil than in *C. bengalensis*, and (as may be seen by comparing the figure of the former with that of *C. littoralis*) are placed closer together;—so close in fact that *pm. 2* and *pm. 3* overlap. In all other species of *Canis* the earlier premolars are elongated and separated by distinct intervals; but in *Otocyon* in size and position they are very similar to the fossil, although there is no overlap, and the antero-posterior shortening is still more pronounced. The skull itself in its short and wide form is nearer to *Canis littoralis* and *Otocyon* than to *C. bengalensis*. On its superior surface it agrees with those forms and the other small alopecoids by the enclosure of a lyrate 'sagittal area'³ by the temporal ridges. Posteriorly these ridges unite to form a small sagittal crest, as in *C. bengalensis*, and *C. corsac*; but the middle part of the sagittal area is wider and more lyrate, and it edges more cord-like than in those species⁴: being in fact in this respect intermediate between those

¹ These characters are not quite so strongly marked on the right side.

² See Huxley, *op. cit.*, fig. 13, p. 260.

³ In the weaker-jawed alopecoids, the temporal ridges, which are separate in all young *Canine*, never unite throughout their length to form a sagittal crest; and the area enclosed by them is termed by Prof. Huxley the sagittal area.

⁴ The excellent figures of the skulls of these forms given by Prof. Huxley may be compared with the figure of the fossil.

species and *C. littoralis* and *Otocyon*. The orbit is much smaller than in any living alopecoid, and thereby agrees with that of the last-named genus. Posteriorly the post-orbital processes of the frontal and the zygoma are considerably more developed than in *C. bengalensis*, and have apparently about the same degree of development as in *C. littoralis*, which in this respect is intermediate between the former and *Otocyon*. On the palatal aspect the posterior free border of the palatines is placed at a considerable distance behind the last true molar; whereas in all other alopecoids and typical *Canine*, this border is placed in advance of the last molar. In *Otocyon*, on the other hand, the free border of the palatines is produced still further back than in the fossil: and in this respect, therefore, the latter is intermediate between the alopecoids and that genus. The fossil is not sufficiently perfect to admit of any closer comparisons.

Mandible.—The mandible associated with the skull described above is represented from the dental aspect in figure 7 of plate XXXII. On the left side it shows the last three premolars, the two first true molars, and the alveolus of $\overline{m. 1}$: the coronoid process remains, but the condyle and characteristic angular process are unfortunately wanting. On the right side, in addition to the teeth shown on the left, there is seen the alveolus of $\overline{pm. 1}$, and the greater part of the canine. In noticing this specimen Mr. Bose observes that "the rami of the lower jaw are not so much compressed as in the living species of the Canidae. Each ramus, instead of being straight, forms an arc of a circle between the angle and the mandibular symphysis. As in the upper jaw, the premolars in the lower jaw also are closer together than in the [Bengal] Fox."

In the following table the dimensions of the specimen are compared with those of the mandible of *Canis bengalensis* belonging to the same individual as the skull of which the dimensions are given above:—

	C. curvipalatus.		C. bengalensis.
	left side.	right side.	
Interval between hinder border of m. 3 and canine	1.8	..	2.0
Width across hinder end of symphysis	0.7	..	0.5
" " m. 2	0.96	..	0.85
Depth at m. 1	0.45	..	0.42
Length of pm. 2	0.24	..	0.27
" " 3	0.25	..	0.29
" " 4	0.28	..	0.32
" " m. 1	0.3	0.35	0.46
" " 2	0.28	..	0.3
" " alveolus of m. 3	0.17	..	0.12
Interval between carnassial and canine	0.94	..	1.5

These dimensions show that, as in the upper jaw, the premolars occupy a relatively smaller space, and are themselves shorter, in the fossil than in the living form. They also show that while on the left side $\overline{m. 1}$ is considerably shorter in the former, on the right this difference is less marked;—in correlation with the larger size of the right $\overline{pm. 4}$. A comparison of the figure of the mandible of the fossil with that of *C. littoralis* (*woodcut fig. 9*), of which the teeth are almost identical

with those of *C. bengalensis*, will also show that the inner cusp of the blade of the former (*best seen on the right side of the figure*) is placed more anteriorly, or more nearly opposite the hinder outer lobe of the blade; in consequence of which the 'cusp-line' becomes less oblique. The table of measurements also shows that $m.3$ is relatively larger in the fossil jaw. In all the above-mentioned points the latter is intermediate between the mandibles of the smaller alopecoids and *Otocyon*, though on the whole nearer to the former.

It has already been mentioned that in the form of the rami of the mandible Mr. Bose has pointed out an important character of the fossil. In all the smaller alopecoids (and apparently in all other species of *Canis*) the two rami of the mandible have their alveolar borders nearly rectilinear, and enclose between them a V-shaped space. In *Otocyon*,¹ on the contrary, the rami are outwardly curved, and consequently enclose between them a narrow U-shaped space. In this respect, as will be seen from the figure, the mandible of *Canis curvipalatus* agrees precisely with *Otocyon*: the only difference in the form of the rami being that they are rather stouter in the former.

Affinities.—From the foregoing comparisons it will be gathered that the species under consideration agrees with the true dogs in the number of its dentition, and thereby differs markedly from *Otocyon*. In respect of the structure of its teeth it is on the whole nearest to the lowest alopecoids, but in many respects it makes a marked step in the direction of *Otocyon*: and it is extremely remarkable that this resemblance is more marked on one side of the skull than on the other, as if the individual were one in the process of transition from one genus to the other. The form of the cranium is also intermediate between the small alopecoids and *Otocyon*; but there are certain characters only found in the latter. The form of the mandible, as far as it is known, is essentially that of *Otocyon*, and quite different from that of any alopecoid.

From the number of the cheek-teeth it seems right to refer the fossil to the genus *Canis* (*Vulpes*); but there is no doubt that it tends in a very marked degree to bridge over the difference between that genus and *Otocyon*. The most probable interpretation of the genetic affinity of *Canis curvipalatus* is that it is a form derived from the primitive ancestral stock of *Otocyon*, and that it is on the direct ancestral line of the existing small alopecoids; its resemblance being greater to the North American *C. littoralis*, than to the Indian *C. bengalensis*.² As already observed, it is difficult to interpret the more specialized condition of the hinder cheek-teeth of the right side of the individual fossil, over those of the left, otherwise than as indicating a species in the process of evolution from the more generalized otocyonoid stock to that of the modern alopecoids.

¹ For a figure of the dental aspect of the mandible of this genus see Filhol, "Mammifères Fossiles de l'Epoque Miocene, etc.," pl. V., fig. 12.

² It is unfortunate that it is impossible to determine to which type the angular process of the fossil form belongs.

Distribution.—The cranium and mandible described above are the only known remains that can be referred to the present species: they were obtained from the typical Siwalik Hills.

Species 2. *CANIS CAUTLEYI*, Bose.

History.—In the memoir already quoted,¹ Mr. Bose described two fragments of the mandible of a large wolf, in the Siwalik collection of the British Museum; one of which had previously been considered by Dr. Falconer as the mandible of *Lutra* (*Enhydriodon*) *sivalensis*. The more perfect of the two specimens was figured by Mr. Bose. In describing his specimens Mr. Bose compared them with the jaw of the living Indian wolf (*C. pallipes*), indicating certain differences between the two; and thought that future discoveries might very possibly establish the specific distinctness of the fossil, in which case he proposed that it should be known as *C. cautleyi*. As the species was first named on the evidence of the mandible, it is better to reverse the order usually adopted in this volume, and commence with that part.

Type mandible.—In figures 6, 6a of plate XXXII. the larger of the two fragments of the mandible mentioned above has been figured, from the external and dental aspects. The specimen belongs to the left side and is broken off anteriorly in front of the carnassial; but posteriorly to the fracture is perfect, with the exception of the summit of the coronoid process. It exhibits the carnassial ($\overline{m.1}$), of which the summit of the second lobe of the blade has been broken off: the second true molar ($\overline{m.2}$); and the alveolus of $\overline{m.3}$, which from some damage appears confluent with $\overline{m.2}$. In the second specimen in the British Museum $\overline{m.3}$ is in position, although somewhat damaged. In describing the specimens Mr. Bose observes that they "indicate an animal of the size of the Wolf; and the form of the teeth is exactly as in that animal. On comparing the two fragments with the lower jaw of the living Indian Wolf [*Canis pallipes*], from the osteological collection of the British Museum, the rami are found to be higher and thicker, and the teeth proportionately smaller in the fossil." The dimensions of the specimen will be given below.

Dublin specimen of mandible.—Among the Siwalik fossils in the Science and Art Museum, Dublin, whose history has been already given, there is an associated portion of the skull and two fragments of the mandible of a wolf, portions of which are represented in the woodcut on the next page (fig. 10). The figured portion of the mandible (A) agrees precisely in every respect with the hinder portion of the mandible described above, and leaves no doubt that the two belong to the same species. The figured portion of the Dublin specimen shows $\overline{m.1}$ and $\overline{m.2}$ in a very perfect, and almost unworn, condition; it also shows the broken fang of $\overline{m.3}$. The fragment of the opposite side shows the canine and the earlier premolars.

Comparisons.—The form of the teeth in these specimens leaves no doubt, as Mr. Bose remarks, that they belonged to a true wolf. The existing wolves of the Old

¹ 'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 135.

World are usually divided into four species;—viz., *Canis lupus* of Europe and parts of Asia, *C. pallipes* of India, and *C. laniger* and *C. chanco* of Tibet. From the fact, however, that the size of the cheek-teeth of all the specimens of these forms measured by him are contained within the limits of variation of those of *C. lupus*, Prof. Huxley¹ is inclined to think that they may all be considered as local races of that species. The table of measurements given below shows, however, that the teeth of *C. pallipes* are on the whole smaller than those of *C. lupus*. The skull of *C. pallipes* is considered by the same writer to be nearest to the jackal type of skull, but there is no essential difference between the skulls and teeth of any of the four species²; and it will accordingly suffice to compare the fossil mandible with the skull of one species; although in a later

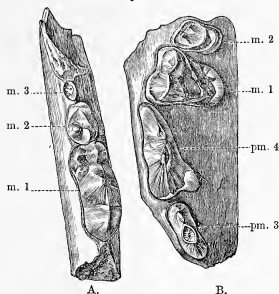


Fig. 10. *Canis cantleyi*, Bose. Part of the left ramus of the mandible (A) and the left side of the palate (B): from associated specimens from the Siwaliks. Dublin Museum. (Nos. 42 and 43.)

paragraph the measurements of the teeth of all the species will be given. The species selected for this comparison is *C. pallipes*; and in the following table the dimensions of the two fossil mandibles are compared with two specimens of the mandible of the former species, one of which (a) is a specimen in the writer's collection, and the other (b) a specimen in the British Museum, of which the dimensions are given by Mr. Bose:—

	<i>C. cantleyi</i> .		<i>C. pallipes</i> .	
	Dublin.	Brit. Mus.	a.	b.
Interval between canine and carnassial	2.26	..	2.24	..
Antero-posterior diameter of canine	0.45	..	0.46	..
Length of <u>pm. 1</u>	0.2	..	0.22	..
" " <u>2</u>	0.47	..	0.44	..
" " <u>3</u>	0.62	..	0.5	..
" " <u>4</u>	0.58	..	0.54	..
" <u>m. 1</u>	0.96	0.95	0.94	1.0
" " <u>2</u>	0.43	0.42	0.45	0.47
" " <u>3</u>	0.2	..	0.22	..
Depth at <u>m. 1</u>	1.04	1.1	1.08	1.02
Greatest depth of angular process	..	0.63	..	0.44
Interval between summit of condyle and inferior border of ditto	..	1.33	..	1.2

These measurements show that in respect of the depth of the horizontal ramus, and the proportionate size of the hinder cheek-teeth, the fossil jaws are within the limits of variation of the jaws of the existing species. In respect of the form of the angular process there is, however, a considerable difference between the figured British Museum jaw of the fossil and that of the living species. In the latter (and apparently in all other existing wolves) the angular process is considerably smaller

¹ *Op. cit.*, p. 278.

² It is more convenient to refer to these different forms as species.

in all its dimensions; and has a recurved upper angle, which is entirely wanting in the fossil. The masseteric fossa is also larger and deeper in the fossil, and the pedicle of the condyle wider and flatter; in consequence of which there is a smaller upward bend of the inferior border below the ascending ramus than in the recent species. In these respects the pleistocene *Cyon europæus*¹ comes nearer to the fossil, though the angular process is smaller than in the latter. The European species is broadly distinguished by the absence of $\overline{m.3}$.

Dublin cranium.—The cranium of which the hinder cheek-teeth of the left side are represented in the woodcut on the last page, as already observed, is associated with the mandible, of which a portion is represented in the same figure, and, therefore, belongs to *Canis cautleyi*. The cranium is broken off anteriorly in front of $\overline{pm.3}$, and is not in a condition to afford a good figure. It presents a strong sagittal crest, and a deep groove along the mesial fronto-nasal line; the post-orbital processes of the frontals are large, and much curved downwards towards the zygomatic arches. Anteriorly it is a good deal crushed: but the hinder part of the palate is fairly perfect, and shows $\overline{pm.3}$, $\overline{pm.4}$, $\overline{m.1}$, and $\overline{m.2}$. The summits of the two former are broken off, but the teeth are otherwise perfect, and scarcely touched by wear. The whole skull and teeth are essentially wolf-like in form. Their dimensions are compared below with those of *C. pallipes*,² viz.:—

	<i>C. cautleyi.</i>	<i>C. pallipes.</i>
Width at post-orbital processes of frontals	2.1	2.24
Interval between ditto and summit of occiput	4.1	3.84
Width of both condyles	1.46	1.51
Interval between $\overline{m.1}$ of opposite sides	1.52	1.32
„ „ tubercles of $\overline{pm.4}$ of opposite sides	1.63	1.62
Length of $\overline{pm.3}$	0.6	0.56
„ „ „ 4	0.96	0.85
Dimensions of $\overline{m.1}$	0.63X0.89	0.6X0.74
„ „ „ 2	0.33X0.49	0.32X0.48
United lengths of $\overline{m.1}$ and $\overline{m.2}$	0.96	0.92
Interval between postglenoid process and $\overline{m.2}$	1.83	1.8

Indian Museum maxilla.—In figure 3 of plate XXXII. there is represented the left maxilla of a wolf, formerly in the collection of the Asiatic Society of Bengal, but now transferred to the Indian Museum. It is alluded to in the Journal of the Society³ as having been obtained by the late Col. Colvin from the Siwaliks of Dádúpúr. In Messrs. Falconer and Walker's Catalogue of the Society's Vertebrate Fossils,⁴ the specimen is alluded to as follows:—“*Canis*.—Upper maxillary, left side, comprising a part of palate and zygomatic portion of orbit, with 4 teeth *in situ*, the three posterior of which are entire, agreeing exactly in form with those of *Canis lupus*, but a little larger.” In its present state $\overline{pm.3}$ has been broken off; and the

¹ Bourguignat, 'Ann. Sci. Geol.,' vol. VI., pl. X.

² The skull of which the measurements are given is the one in the writer's collection, already alluded to.

³ Vol. V., p. 184. No. 603.

⁴ Calcutta, 1859, p. 189. No. S. 852. A portion of this notice is copied on p. 313 of vol. I. of the "Palaeontological Memoirs."

summit of the blade of pm.4 considerably damaged. The two true molars are intact, and from their somewhat worn condition indicate the fully adult age of the animal to which they belonged. The teeth agree almost precisely with those of the Dublin cranium; the only distinction between the two being a slight difference in the form of m.2, which is probably only an individual variation. The specimen exhibits a very deep depression in the palate between pm.4 and m.1 (*not well shown in the figure*); which is more marked than in existing wolves. The dimensions of the specimen are as follows, *viz.* :—

Length of <u>pm.3</u>	. . . . .	(?) 0.57
" " " <u>4</u>	. . . . .	0.95
Dimensions of <u>m.1</u>	. . . . .	0.61X0.82
" " " <u>2</u>	. . . . .	0.32X0.49
United length of <u>m.1</u> and <u>m.2</u>	. . . . .	0.93

Comparisons.—In the following table the dimensions of the hinder cheek-teeth of these two specimens are compared with those of various individuals of the existing species of Old World wolves,¹ *viz.* :—

	<i>C. pallipes</i> 1	<i>C. pallipes</i> 2	<i>C. pallipes</i> 3	<i>C. lupus</i> 1	<i>C. pallipes</i> 4	<i>C. chanco</i>	<i>C. lupus</i> 2	<i>C. cauleyi</i> 1	<i>C. cauleyi</i> 2	<i>C. laniger</i>	<i>C. lupus</i> 3	<i>C. lupus</i> 4
Length of <u>pm.4</u>	0.85 0.86		0.87 0.94	0.95 0.95	0.95 0.95	0.96 0.99	1.1 1.16				
" " <u>m.1</u>	0.6 0.6		0.62 0.64	0.64 0.66	0.61 0.63	0.64 0.68	0.68				
Breadth, " "	0.74 0.66		0.68 0.66	0.7 0.77	0.82 0.89	0.68 0.78	0.78				
Length, " <u>m.2</u>	0.32 0.32		0.35 0.32	0.32 0.37	0.32 0.33	0.32 0.37	0.37				
Breadth, " "	0.48 0.42		0.53 0.42	0.48 0.53	0.49 0.49	0.46 0.54	0.53				
Length, " <u>m.1</u>	0.94 0.96	1.0	1.05 1.02	1.13 1.1	0.95 0.96	1.13 1.18	1.18				
" " <u>m.2</u>	0.45 0.4	0.47	0.42 0.47	0.48 0.48	0.42 0.43	0.44 0.45	0.5				
" " <u>m.3</u>	0.22		0.22 0.22		0.24	0.2 0.17	0.21	0.22			
United length of <u>m.1</u> and <u>m.2</u>	0.92 0.92		0.97 0.96	0.96 1.03	0.93 0.96	0.96 1.05	1.05				

It will be seen from this table that the carnassials of *C. pallipes* are on the whole shorter than those of *C. lupus*; although there is an overlap in this respect between the largest of the former and the smallest of the latter. It will also be observed that in all the individuals of the former m.1 is considerably longer than pm.4; but that the proportionate difference diminishes as the teeth become absolutely larger. The same may be observed in the case of *C. lupus*, but still more markedly, so that in one case pm.4 is but very slightly shorter than m.1. It appears, therefore, that in these species as the carnassial teeth increase in absolute size, the increase of the upper tooth is greater than that of the lower. In all the individuals of these two species of which the measurements are given, the united length of m.1 and m.2 is greater than that of pm.4. In *C. chanco*, however, this excess is very slight, and in *C. laniger* the latter dimension is the larger of the two.

In the Siwalik wolf pm.4, which is about equal in size to the average of that

¹ In this table *C. pallipes* 1 is the specimen in the writer's collection, already alluded to; and *C. pallipes* 2 the specimen of which the measurements are given by Mr. Bosc: the dimensions of *C. cauleyi* 1 are from the specimens figured in plate XXXII. of this volume: and *C. cauleyi* 2 from the Dublin specimens. The other measurements are taken from the table in Prof. Huxley's memoir (p. 279), and have been altered from millimetres to decimals of an inch.

tooth in *C. lupus*, is of precisely the same length as $\overline{m.1}$; the length of the latter being much smaller than that of the same tooth in any individuals of the living species having an upper carnassial of the same size. The larger individuals of *C. lupus* make the closest approach in this respect to the fossil, but even in the nearest of those $\overline{m.1}$ is decidedly longer than $\underline{pm.4}$. The fossil also differs from all the living species, except *C. luniger*, in having the united length of $\underline{m.1}$ and $\underline{m.2}$ either equal to, or less than that of $\underline{pm.4}$. The first upper true molar of the fossil differs from the corresponding tooth of *C. lupus*, in having the outer lobes, and especially the hinder one, less completely conical; being distinctly compressed laterally: the outer cingulum is also more developed. In these respects the tooth of the fossil resembles the corresponding tooth of the jackal.

On the whole, apart from the question whether the living Old World wolves should be referred to one or more species, it appears probable that the differences in the form of the angular process of the mandible, and the above-mentioned relations of the carnassial teeth, indicate the specific distinctness of the Siwalik wolf from any of its existing Old World congeners. Seeing that in the meionocercodont alopecoids $\overline{m.1}$ is always longer than $\underline{pm.4}$, it would seem that in cases where these two teeth are equal in length the degree of specialization is the greatest, and it may, therefore, be concluded that the Siwalik wolf was probably a more specialized animal than any of the existing species; certain individuals of *C. lupus* coming nearest in this respect. The equality in the length of $\underline{pm.4}$ and the united length of $\underline{m.1}$ and $\underline{m.2}$ is also indicative of a high degree of specialization in the Siwalik wolf. There are not wanting, as will be noticed below, other instances where Siwalik carnivores are more specialized than their existing allies; and if the above conclusions be true it would seem doubtful whether the Siwalik wolf can have been the direct ancestor of any of the living forms: this is perhaps confirmed by the marked discrepancy in the proportions of its carnassial teeth to those of the existing Indian wolf.

Among the existing wolves, or thooids, of America, according to Prof. Huxley's measurements,¹ the only species which has carnassial teeth at all approaching in size those of the Siwalik fossil is the North American *C. occidentalis*: in that species, however, $\underline{pm.4}$ is always shorter than $\overline{m.1}$. In the peculiar S. African *Lycaon* $\underline{pm.4}$ is considerably shorter than $\overline{m.1}$, and the corresponding tooth of the fossil. All species of *Cyon* are distinguished from the fossil by the absence of $\overline{m.3}$; while *Lycaon* is distinguished by the absence of $\underline{pm.1}$. In the pliocene of Italy there occurs *Canis etruscus*, Forsyth-Major;² a wolf distinguished from existing species by the larger size of the talon of $\overline{m.1}$, and the greater development of the cusps of the same part: those cusps frequently attaining nearly the same height as the anterior lobe of the blade. The inner cusp of the blade is also larger and more detached. The general form of the mandible is nearer that of the wolf than that of the Siwalik fossil; and $\underline{m.1}$ has its outer lobes of the conical form of those of the former. *Canis fulconeri*, of

¹ *Op. cit.*, pp. 267, 271.

² *Atti. Soc. Tosc. Sci. Nat.*, vol. III., p. 268, pls. XIII.-IV.

the same writer,¹ is readily distinguished by the form of pm. 4, which is set very obliquely, and remarkable for the great size of its inner tubercle.

In the pleistocene *Canis neschernensis*, Christol² (if a good species), is distinguished by its more slender mandible; and *C. lupus* seems to be the only other wolf equal in size to the Siwalik species. In the pre-historic period various large dogs have received the names of *C. familiaris spalleti*, *C. f. palustris*, *C. f. matris-optima*, *C. mikii*, etc., and seem to be related to the wolf, jackal, etc.³

In North America species resembling the modern wolves and dogs are, as already said, known in the upper miocene. One of these is referred by Prof. Cope⁴ to *C. lupus*, Linn., but from the context it would seem that one of the living American wolves is the one with which the fossil is identified: if the identification be correct the persistence of a miocene mammal is highly remarkable. *C. wheelerianus*,⁵ Cope, *C. ursinus*,⁵ Cope, and *C. haydeni*,⁵ Leidy, from the same formation are distinguished from the Siwalik wolf by their much greater depth of jaw; and it is not improbable that the two latter may belong to *Amphicyon*. Most of the other fossil American species of *Canis* are smaller than *C. lupus*; but a lower jaw from the pliocene has been described by Prof. Leidy under the name of *C. indianensis*,⁶ and said to belong to a large wolf, which may be the same as *C. occidentalis*. The angular process of this jaw is quite different from that of the Siwalik fossil.

Conclusions.—From the foregoing comparisons it appears that the Siwalik wolf cannot be certainly identified with any described form, although in many respects it was closely related to the existing wolves of the Old World. Under these circumstances the name of *Canis cautleyi* may be retained. The occurrence of this fossil in the Siwaliks is one of extreme importance in regard to the pliocene age of at least a large portion of those deposits, for, as has been already shown, in the tertiaries of Europe, with which the Siwaliks are in many respects closely allied, true wolves are unknown before the pliocene; though they are said to occur in the upper miocene of N. America. The total absence of all forms of true *Canis* from the Pikermi deposits is a very noteworthy fact.

Distribution.—The specimens described above are the only known remains which can be referred to the present species; and were all obtained from the typical Siwalik Hills.

Species 3. *CANIS*, *non. det.*

Maxilla.—In figure 2 of plate XXXII. there is represented a fragment of the right maxilla of a species of *Canis* from the typical Siwaliks, in the collection of the British Museum. The specimen shows the alveolus of pm. 3; the carnassial (pm. 4), with the summits of the lobes hammered off; and m. 2, of which the inner cingulum

¹ *Ibid.*, pl. XIV., fig. 20.

² Blainville, "Ostéographie," Genus *Canis*, pl. XIII.

³ See Bourguignat, *op. cit.*, and Woldrich, 'Mith. Anthropol. Ges. Wien,' vol. XI, pt. I., 1881.

⁴ 'Rep. U. S. Geog. Survey, W. of 100th Meridian,' vol. IV., p. 302.

⁵ Cope, *op. cit.*, p. 301., *et. seq.*

⁶ Leidy, "Extinct Vertebrate Fauna of the Western Territories," p. 230, pl. XXXI.

is wanting, and the crown almost unworn. In the following table the dimensions of this specimen are compared with the corresponding dimensions of three crania of the jackal (*C. aureus*) in the writer's collection, one of which (*a*) was obtained from the Punjab, while the other two came from Káshmir:—

	C. aureus.	Siwalik jaw.	C. aureus.
	a.		b. c.
Length of pm. 3	0·39	0·42	0·43 0·42
" " " 4	0·64	0·68	0·68 0·69
" " m. 1	0·48	0·52	0·51 0·54
Width " " "	0·58	0·62	0·62 0·63

These dimensions show that the size of the fossil is practically the same as that of the middle individual of *C. aureus*. The teeth of the two agree precisely in every detail—notably in the large size of the external cingulum;—and if both were found in the fossil state would be unhesitatingly referred to the same species. The materials at hand are not sufficient to say positively whether the Siwalik and living forms were specifically the same; but there can be no question that they were extremely closely allied, and that the former was as much a true jackal as the latter.

FAMILY III.: VIVERRIDÆ.

Relationships.—At the present time the family *Viverridæ* embraces a large number of æluroid Carnivora, exhibiting affinities to at least two other families. Thus it is related by *Herpestes* with *Proteles*, and so with *Hyæna*; while by *Genetta* it is more intimately connected with *Felis*. In former times there are strong indications that its connections were even wider; since, as has been mentioned above, it is highly probable that its connection through *Cynodictis* and its allies with the true dogs is so intimate as to preclude the drawing of any well-marked line between the dogs and viverrines. On the other hand, the typical forms of the family are intimately connected through *Ictitherium* with *Hyæna*; while in another direction there seems to be a complete passage from *Viverra* through certain genera from Quercy known as *Stenoplesictis* and *Palæoprionodon* to *Proclurus* and *Pseudaelurus*, and so to the modern cats.¹ For the present, however, the family may be retained even for palæontological purposes; although it is highly probable that it cannot be strictly defined.

Dental characters of Viverrine sub-family.—Before proceeding to the description of the Siwalik forms which can be referred to the present family, it will facilitate their description if it is first pointed out how the existing genera of the group to which they belong can be distinguished in respect of characters observable in the fossil forms. According to Professor Mivart,² the existing members of the family may be divided into five sub-families:—viz. *Viverrinæ*, *Galidictinæ*, *Euplerinæ*, *Cryptoproctinæ*, and *Herpestinæ*; but attention need only be directed to the first. That sub-family is again divided into the viverrine, paradoxurine, and

¹ See Filhol, "Mémoires sur quelques Mammifères Fossiles des Phosphorites du Quercy," pp. 88-90.

² "Pro. Zool. Soc." 1882, p. 135, et seq.

cynogaline sections; of which the first alone need be considered at any length. According to the same authority the first of these sections comprehends the following six genera: viz., *Viverra*, *Viverricula*, *Fossa*, *Genetta*, *Prionodon*, and *Poiana*: the two first are, however, united by many writers. The two last are distinguished by the absence of *m. 2*; and on this account will not require further notice, since that tooth is present in the fossils to be described. In the four remaining genera, the number of the cheek-teeth is *pm. 4*, *m. 2*; as in *Cyon*.

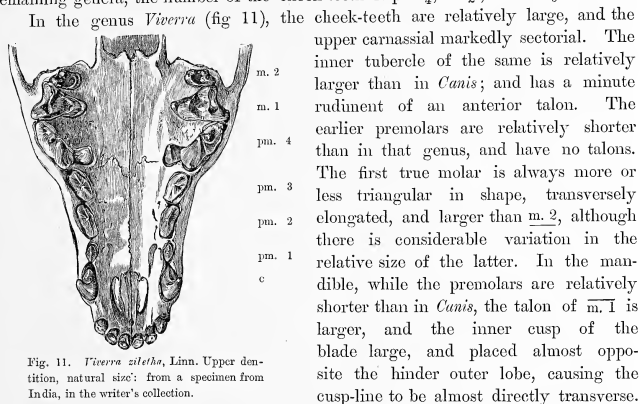


Fig. 11. *Viverra zibetha*, Linn. Upper dentition, natural size: from a specimen from India, in the writer's collection.

The dentition of *Viverricula* (comprehending only *V. maluccensis*) is so like that of *Viverra*, that for palæontological purposes they may be united. Probably the same may be affirmed of *Fossa*¹, of Madagascar. The genus *Genetta* in addition to numerous points which are inapplicable to the present enquiry, differs from *Viverra* in the more distinctly triangular form of the auditory bulla;² and the teeth of the latter are, according to Professor Mivart,³ distinguished from those of the former in that *m. 2* is in general, and especially in *V. tangalunga*, relatively larger and more obtusely triangular, or even nearly quadrangular, and is more nearly equal in size with the tooth in front of it; *m. 1* has a relatively larger internal portion, while in both *pm. 4* and *m. 1* the talon is larger, that of *m. 1* (if not that of *pm. 4* also), bearing three small cusps.⁴ In *Genetta pm. 3* has usually an inner

¹ Mivart. *op. cit.* p. 152.

² The bulla of *Viverricula* is more like that of *Genetta*.

³ *Ibid* pp. 153-4. In the original of this passage, as may be inferred from the note at the conclusion (*5 infra*) the words *Viverra* and *Genetta* are apparently transposed. In consequence of this *V. tangalunga* is noticed as an exception, instead of as the most marked instance: this has been corrected in the quotation.

⁴ A skull (associated with a skin) in the British Museum, and named *G. tigrina* has *m. 2* very minute and triangular. A specimen in the College of Surgeons, with the same name has, however, this tooth as large as *m. 1*. It is difficult to think that these two specimens belong to the same species.

⁵ Well shown in *Viverra zibetha*, pl. XII of De Blainville's "Ostéographie," Gen. *Viverra*.

cuspid,¹ which is wanting in most species of *Viverra*.² Another important point is that all species of *Genetta* are small sized.

It may not be out of place to observe that the teeth of *Paradoxurus* closely approach those of some species of *Viverra*, but are in general distinguished by the shorter form of $\overline{\text{pm. 4}}$, the presence of an inner cusp to $\overline{\text{pm. 3}}$, and the more quadrangular form of $\overline{\text{m. 1}}$; the skull is also shorter and wider, and the auditory bulla more pointed anteriorly. In *Herpestes*, which has also teeth of a similar type, there is an inner cusp to $\overline{\text{pm. 3}}$, and the bulla is mesially contracted. In respect of the large development of the inner tubercle of $\overline{\text{pm. 4}}$, and the large talon and inner cusp of $\overline{\text{m. 1}}$, the teeth of *Viverra* and *Genetta* must probably be regarded as being of a lower type than those of *Canis*; although the suppression of $\overline{\text{m. 3}}$ is an advance on that genus. A considerable advance is indicated in the fossil genus *Ictitherium*, in which the minute anterior cusp existing in $\overline{\text{pm. 4}}$ of *Viverra* has developed into a distinct additional lobe to the blade; while in $\overline{\text{m. 1}}$ the talon and inner cusp have considerably diminished; these two teeth being in fact about intermediate between those of *Viverra* and the less specialized forms of *Hyaena*. *Ictitherium* retains, however, $\overline{\text{m. 2}}$, which is never found in any species of *Hyaena*; although $\overline{\text{m. 2}}$, in a smaller form, is present in some species of the latter. There is a tendency to the suppression of $\overline{\text{m. 2}}$ exhibited by the small size to which that tooth is reduced in some species of *Ictitherium*.³

GENUS I.: VIVERRA, Linné.

Number of species.—According to Professor Mivart,⁴ the existing species of *Viverra* proper are four in number; which will be raised to five if *Viverricula* be included. The following list embraces these species, together with the best known fossil forms, exclusive of those from India.

1. VIVERRA ANGUSTIDENS, Filt.⁵ Quercy phosphorites.

A species as large as *V. zibetha*, but with a shorter mandible, which is the only part known; and a small talon to $\overline{\text{m. 1}}$, the blade of the same being unusually tall.

2. VIVERRA ANTIQUA,⁶ Blain. Up. miocene. Allier. *V. primæva*, Pom.

A small species with hinder molars, closely resembling *V. malaccensis*; but with shorter palate.

3. VIVERRA CIVETTA,⁷ (Schreb). Recent. North and West Africa.

The largest living species; $\overline{\text{m. 2}}$ relatively large; $\overline{\text{m. 1}}$ large internally; $\overline{\text{pm. 4}}$ short.

4. VIVERRA EXILIS,⁸ Blain. Mid. miocene. Sansan.

A minute species, of which the generic determination is very doubtful.

5. VIVERRA LEMANENSIS,⁹ Gerv (?). Up. miocene. Allier.

Considerably smaller than *V. zibetha*; with shorter palate.

¹ A specimen of *G. vulgaris* (B.M. No. 993, a) has no such cusp.

² The writer has not seen a skull of *V. megaspila*.

³ A Siwalik species of *Ictitherium* has been named; the specimen on which it is founded will, however, be shown in the sequel to belong to the *Hyaenida*.

⁴ *Op. cit.*, p. 145.

⁵ "Phosphorites du Quercy." Figs 121-2.

⁶ Gervais. "Zool. et Pal. Franç." 1st Ser., pl. XXVIII, figs. 7-8. Pomel. "Bul. Soc. Geol. Franç." 1846, p. 379

⁷ Blainville. "Ostéographie." Viverra, plate VIII.

⁸ Gervais, *op. cit.*, p. 224.

⁹ Cast of skull in College of Surgeons.

6. *VIVERRA LEPTORHYNCHA*, Filh.¹ Quercy phosphorites. *Ichneugale*, Jourdain.
A small species, with small talon to $\overline{m. 1}$; upper dentition unknown except $\overline{pm. 4}$.
7. *VIVERRA MALACCENSIS*, Gmel. Recent. India to China. *V. indica*, Geof.
V. pallida, Gray. *V. rasse*, Horsf. *Viverricula*, Hodgs.
A very small species: $\overline{m. 2}$ very small.
8. *VIVERRA MEGASPILA*.² Blyth. Recent. Malacca to Cochin China.
Twice the size of *V. tangalunga*.
9. *VIVERRA MINIMA*, Filh.³ Quercy phosphorites.
A very minute species, with small talon to $\overline{m. 1}$.
10. *VIVERRA SANSANIENSIS*,⁴ Lart. Mid. miocene. Sansan.
A small species.
11. *VIVERRA TANGALUNGA*,⁵ Gray. Recent. Malacca, Borneo, etc.
The smallest living species: $\overline{m. 2}$ relatively large.
12. *VIVERRA ZIBETHA*,⁶ Linn. Recent. India, China, and Penang. *V. bengalensis*, Gray. *V. civettina*, Blyth. *V. civettoides*, *V. melanura*, and *V. orientalis*, Hodgs. *V. undulata*, Gray.
Generally rather smaller than *V. civetta*: $\overline{m. 2}$ relatively smaller, inner part of $\overline{m. 1}$ smaller and $\overline{pm. 4}$ longer.

The mandible of another form, is figured without specific determination, by M. Filhol,⁷ from Quercy; and indicates an animal about the size of *V. zibetha*, but with a shorter mandible, and smaller talon to $\overline{m. 1}$. The general shorter form of the jaws in so many of the fossil species, as well as the smaller size of the talons of $\overline{m. 1}$ (a character of *Genetta*), are remarkable points, as in the dogs and cats these characters are indications of high specialization. *V. zibethoides*, Blain.=*Amphicyon*; and *V. parisiensis*, Blain., belongs to another genus; and the same may probably be said of *V. gigantea*.⁸

Distribution.—The genus *Viverra* is at the present time exclusively Asiatic, while the whole living family is confined to the Old World. The fossil forms mentioned above, some of which from the small size of the talon of $\overline{m. 1}$ may possibly belong to *Genetta*, are all confined to the Old World: the genus commenced in the upper eocene.

Species 1. *VIVERRA BAKERI*, Bose.

Syn. *Canis*? sp., Falc. and Caut.

History.—In the supplemental plates of the "F.A.S."⁹ there are represented a cranium, and the portion of a left maxilla of a small Siwalik carnivore, in the British Museum; entered doubtfully in the description of the plates¹⁰ as *Canis*. Recently Mr. Bose¹¹ has described these specimens under the name of *Viverra bakeri*.

¹ "Notes sur quelques Mammifères, etc." *op.cit.*, pl. IV.

² Günther, "Pro. Zool. Soc." 1876, p. 428.

³ "Phosphorites du Quercy" figs 334-6.

⁴ Gervais *op. cit.*, pl. XXII, fig. 1.

⁵ Gray, "Pro. Zool. Soc." 1832, p. 63.

⁶ Woodcut, fig 11, supra, p. 266

⁷ "Phosphorites du Quercy," figs 115-6.

⁸ Blainville "Ostéographie," Genus *Viverra* pl. XIII.

⁹ Pl. Q. figs 1, a, b, 3.

¹⁰ "Palaeontological Memoirs," vol. I, p. 553.

¹¹ "Quart. Journ. Geol. Soc." vol. XXXVI, p. 131.

Cranium.—The above-mentioned cranium is represented of the natural size in figures 1, 1a, of plate XXXIII of the present volume. It is considerably damaged, apparently from lesions before it became buried in the rock; but the hinder part of the palate is fairly perfect, and exhibits on either side the four last check-teeth in excellent preservation. The elongated form of the cranium indicates without doubt the viverrine affinities of the specimen; while its large size, absence of any inner cusp to pm. 3, large inner portion of m. 1, and relatively large size of m. 2, are all distinctive characters of *Viverra* as given above. Mr. Bose's generic determination may accordingly be accepted.

In describing the specimen, Mr. Bose observes: "The skull indicates an animal of nearly the same size as the Civet (*V. civetta*). The third premolar, which is proportionately larger than the corresponding tooth in the latter, consists of a stout triangular crown, and presents no division into accessory lobes, anteriorly, or posteriorly. The cingulum is well pronounced, and sends up a ridge anteriorly, which, meeting with its fellow from behind, divides the crown into two parts, of which the external is much more convex than the internal. The sectorial [pm. 4] is like the corresponding tooth in the Civet, but proportionately larger. The anterior of the two lobes into which its blade is divided is thick and conical, with a small accessory lobule in front, and is mapped off by a notch from the posterior lobe. The internal tubercle is stout and strong, and separated by a deep valley from the outer lobes, as in the Civet. The first tubercular [m. 1] is triangular and tricuspid, and is a little larger than the corresponding tooth in that species. The two sub-equal outer cusps are ground down into flattened crescent-shaped disks; and the inner cusp is separated from them by a deep pit. The second tubercular [m. 2] is proportionately longer laterally [transversely], and narrower antero-posteriorly than the corresponding tooth in the Civet."

In the following table the dimensions of the fossil cranium (a),¹ and of the maxilla (b) represented in figure 2 of the same plate, are compared with those of *V. civetta* and *V. zibetha*. The specimens of *V. civetta*, are (a) one in the British Museum (No. 138, d); (b) another in the same collection (No. 76, 9, 26, 13); and one (c) figured by De Blainville²; those of *V. zibetha* are (a) one in the writer's collection (fig. 11), and (b) another in the College of Surgeons (No. 455).

	V. bakeri		V. civetta				V. zibetha	
	a.	b.	a.	b.	c.		a.	b.
Length of inferior surface			5.4	5.7	5.3		5.08	5.5
Width between pm. 4 and m. 1	1.96		1.84	1.87	1.85		1.76	1.96
" " at pm. 2	1.07		1.13	1.1	1.19		0.88	1.03
Length of 4 last check-teeth	1.44		1.3	1.38	1.25		1.3	
" " 2 true molars	0.59		0.6	0.62	0.57		0.53	0.49
" " pm. 3	0.44		0.34	0.35	0.34		0.35	
" " pm. 4	0.62	0.63	0.5	0.5	0.48		0.6	0.6
Width of pm. 4 at tubercle	0.37	0.38	0.38	0.4	0.41		0.35	
External antero-posterior, diatmeter of m. 1	0.35	0.38	0.37	0.38	0.35		0.35	0.31
Internal " " " "	0.28	0.27	0.28	0.3	0.28		0.22	0.22
Transverse " " " "	0.56	0.55	0.55	0.48	0.58		0.55	0.5
Antero-posterior " " m. 2	0.23		0.28	0.28	0.26		0.19	0.19
Transverse " " " "	0.4		0.35	0.35	0.39		0.32	0.24

¹ Mr. Bose makes most of these dimensions slightly smaller.

² "Ostéographie"—Viverra, pl. VIII.

In *V. civetta* *b* m. 1 is remarkably short transversely; in another specimen in the British Museum (No. 138, *b*) m. 2 is extremely large, its transverse diameter being 0·43; pm. 4 is unusually short in the same specimen, its length being only 0·45.

These dimensions show that in the fossil the carnassial is about the same size as

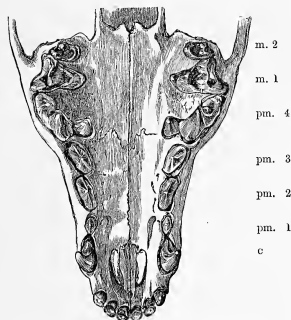


Fig. 12. *Viveria zibetha*, Linn. Upper dentition, natural size: from a specimen from India, in the writer's collection.

that of the zibeth, its length considerably exceeding the united length of the two true molars; whereas in the civet the latter diameter is considerably the larger of the two. The true molars of the fossil (as may be seen by a comparison of the figure of the latter with the accompanying woodcut) are, however, different from those of the zibeth; the inner portion of m. 1 being longer antero-posteriorly, and m. 2 altogether larger: in this respect they agree very nearly with those of the civet; m. 2 being rather larger than is generally the case in that species. The third premolar is larger than in either of the existing species. As it has been shown above that in the dogs a relatively large upper

carnassial (megaloecreodontism), with a reduction in the size of the last true molar, is indicative of high specialization, it may be assumed that the same will probably hold good for the civets¹; and consequently that the zibeth is a more specialized animal than the civet. The Siwalik civet must be regarded as intermediate between the two, its carnassial having attained the proportions of that of the zibeth, while its true molars retain the large size of those of the civet.

In respect of other characters the condition of the fossil allows of very few observations. As the skull appears to agree in size with the zibeth marked *a*, it appears that its palate is relatively wider than in that species, and thereby agrees with the civet. Similarly the palate of the fossil, like that of the civet, is produced to a greater extent behind the last molar than in the zibeth. Superiorly the fossil skull seems to be as much elongated as in the latter.

Left maxilla.—The left maxilla represented in figure 2 of plate XXXIII., of which the measurements have been already given, is another specimen in the Siwalik collection of the British Museum. The second true molar has been broken away; but the resemblance of the remaining teeth to those of the type cranium is so close that the two may be safely referred to the same species.

Distinctness as a species.—The foregoing comparisons leave no doubt of the

¹ The word civet may be used in two senses: firstly, as applicable to the whole genus *Viveria*, and secondly, as applicable only to *V. civetta*.

specific distinctness of the Siwalik civet both from *V. eivetta* and *V. zibetha*; and as the other living species (as well as *Fossa*) are all considerably smaller than the latter, the fossil cannot be the same as any living species. Of the named fossil species given in the foregoing list the only one approaching in size to the Siwalik form is *V. angustidens*, of which only the mandible is known. That part indicates, however, a shorter-jawed animal than the Siwalik civet; while the extremely short talon of $\overline{m.1}$ is very different from the corresponding part in the civet and zibeth: the relative shortness of the whole of $\overline{m.1}$ in *V. angustidens* is moreover quite unlike the form of that tooth in the zibeth. Since it is probable that $\overline{m.1}$ of the Siwalik fossil was very similar to that of the zibeth, it is pretty certain that the former is specifically distinct from *V. angustidens*: and it may accordingly rank as a distinct species, under the name applied by Mr. Bose.

The megalocrodon character of *Viverra bakeri* indicates that it cannot in all probability have been the ancestor of the African *V. eivetta*: it is, however, extremely probable that it may have given rise to the Indian *V. zibetha*; the reduced size of the true molars of the latter being a later specialization.

Distribution.—The two specimens described above are the only ones that can be referred to *V. bakeri*; and were both obtained from the typical Siwalik Hills.

Species 2. *VIVERRA DURANDI*, n. sp., *nobis*.

Syn. (?) *Canis*, sp., *Falc.* and *Caut.*

History.—The specimen on which this species is founded is mentioned here for the first time; while a second specimen has been hitherto referred to another genus.

Cranium.—In figure 3 of plate XXXIII. there is represented from the palatal aspect the cranium of a viverroid animal from the Siwaliks, lately presented by Prof. George Busk to the British Museum, which was originally in the possession of Dr. Falconer, and was probably obtained from the typical Siwalik Hills. The specimen has lost its anterior portion, which has been separated by an oblique fracture a short distance in advance of $\overline{pm.4}$: the hinder part of the palate shows the last three cheek-teeth of either side in fair preservation. On the left side the zygomatic arch is preserved; but the specimen is so fragile that it has not been deemed advisable to clear it from matrix. The auditory bulla of the same side is present; as well as the right occipital condyle (*con*). On the superior aspect (*not figured*) the frontal and parietal regions are well exposed, and are in fair preservation.

The form of the whole skull and teeth leaves no doubt that the specimen should be referred to the present group of animals. Its extremely large size, the anteriorly pointed auditory bulla, the relatively large size of $\overline{m.2}$, and the large inner portion of $\overline{m.1}$, are all characters of *Viverra*, as distinct from *Genetta* and other genera; and the specimen may, therefore, be referred to the former. In the following table its dimensions are compared with those of the skulls of *V. bakeri*, *V. eivetta*, and *V. zibetha*, mentioned in the preceding table:—

	Specimen.	V. bakeri.	V. civetta.	V. zibetha.
Length from foramen magnum to hinder border of palate	3·42		2·26	2·35
" " " " " " " " m. 2	3·75		2·69	2·5
Width between pm. 4 and m. 1	2·82	1·96	1·85	1·76
" , at post-orbital processes of frontals	1·8		1·55	1·1
Greatest zygomatic width	4·4		3·1	2·47
Width of cranial box at posterior zygomatic root	1·98		1·76	1·53
Length from post-orbital process of frontal to occipital crest	3·95		3·0	2·94
Greatest diameter of occipital condyle	0·82			0·61
Vertical diameter of orbit	1·0			0·88
Length of two true molars	0·7	0·59	0·57	0·53
" , pm. 4	0·79	0·62	0·48	0·6
Width " , " , at tubercle	0·55	0·37	0·41	0·35
External antero-posterior diameter of m. 1	0·46	0·35	0·35	0·35
Internal " " " " " " " "	0·34	0·28	0·28	0·22
Transverse diameter of ditto	0·72	0·56	0·58	0·55
Antero-posterior diameter of m. 2	0·26	0·23	0·26	0·19
Transverse " " " " " " " "	0·4	0·4	0·39	0·32

It will be seen from these dimensions that the present specimen is very much larger than the skulls of either of the other three species:—so much so in fact that on this ground alone it is probable that it should be referred to a distinct species. In regard to other points, it will be observed that the length of pm. 4 is greater than the united length of m. 1 and m. 2; indicating that the specimen is a megalocercodont form, and, therefore, specifically distinct from *V. civetta*. In regard to *V. bakeri*, it will be seen from the measurements that in the specimen m. 1 becomes relatively narrower internally; more nearly resembling in this respect the corresponding tooth of the zibeth. The proportionate size of m. 2 is, however, about the same as that of *V. bakeri*; and, therefore, larger than that of the zibeth; its antero-posterior diameter is relatively smaller than that of the corresponding tooth of the civet. In both *V. bakeri* and *V. zibetha* the inner border of m. 1 is placed in advance of that of m. 2, whereas in the present specimen these borders occupy the same antero-posterior line. The outer border of m. 2 in the latter forms a continuation of that m. 1; this line being placed very obliquely to the antero-posterior axis of the skull: in *V. bakeri*, on the contrary, the outer border of m. 2 is placed externally to that of m. 1, and both are set less obliquely to the cranial axis. The zibeth is in these respects more like the present specimen. The angle formed by the junction of the outer borders of pm. 4 and m. 1, m. 2 in the present specimen is, however, much less open than in either of the other species. The hinder border of the palate is very different from that of the zibeth, being produced some distance behind m. 2, in the manner of *V. bakeri*: it appears, however, that the form of the opening of the posterior nares is somewhat different in the two, as may be seen from a comparison of the figures. In *V. bakeri* the frontals are less contracted behind the post-orbitals, while the hinder part of the skull is relatively shorter. Further comparisons between the two are impossible; but it would appear from the differences mentioned above, together with the great discrepancy in respect of size, that the skull under consideration is specifically distinct from that form. In addition to the points of distinction already

¹ It will, however, be shown below that there is a specimen intermediate in size.

mentioned, the specimen differs from *V. zibetha* in the greater proportionate width of the frontals across the post-orbital processes, which is but very slightly, instead of very considerably, less than the width of the hinder part of the cranial box. In front of the post-orbital processes the frontals of the fossil skull contract much more rapidly; and their lateral surfaces, with the adjacent surfaces of the maxilla, are placed at right angles to their superior surface, instead of at an obtuse angle. Posteriorly also the sagittal ridges of the frontals are more strongly developed; and with the sudden anterior contraction of the frontals, cause the middle part of those bones to form a nearly perfect diamond-shaped space, quite different from the corresponding part of the civet or zibeth. The orbit of the fossil is relatively smaller. These differences indicate the specific distinctness of the fossil from *V. zibetha*.

Of the other undoubted species of *Viverra* given in the foregoing list, the only one approaching in size to *V. zibetha* is *V. angustidens*: the lower jaw of that form is, however, too small to have belonged to the present specimen: and the extreme shortness of $\overline{m.1}$ indicates that it belonged to a species in which $\overline{pm.4}$ was short. The so-called *V. gigantea* cannot belong to the same species as the present specimen, since it is markedly meionocreodont, and its lower teeth are very different from those of *V. zibetha*.

It seems, therefore, that the fossil under consideration is specifically distinct from any described species of *Viverra*; all of which it greatly exceeds in size. It may be appropriately named *V. durandi*, in honour of the late Sir H. M. Durand, the associate of Sir W. E. Baker in the early collection and description of Siwalik fossils.

Second specimen.—In plate Q, figures 2, 2a, of the supplement to the "Fauna Antiqua Sivalensis" there is figured, under the name of *Canis* (?) sp.,¹ the anterior part of a cranium of a carnivore from the Siwaliks, now in the British Museum (No. 37,150). The specimen has been broken off anteriorly in front of the canine, and posteriorly in the middle of the cranial box; the whole of the teeth have either dropped from their sockets, or have been hammered off. The whole contour of the specimen, and especially the production of the palate far behind the socket of $\overline{m.2}$, shows that the specimen is not a canine, but a viverrine carnivore. The middle portion of the skull (which is the only part common to the two specimens) precisely resembles the corresponding part of *V. durandi*, as may be seen by anyone who takes the trouble of comparing the two specimens in the British Museum²; the peculiar diamond-shaped frontals, with their sudden fore-and-aft contractions, being as well displayed in one specimen as in the other: the vertical lateral surfaces of the frontals are also the same in both. On the palatal aspect also the two specimens appear perfectly similar, the palate being produced in the same manner behind $\overline{m.2}$; and

¹ See "Paleontological Memoirs," vol. I., p. 553.

² As the number of plates required for this memoir is very large the writer has been compelled to omit figures of some specimens: he has preferred to do this in the case of specimens in the British Museum, which are easily accessible, rather than in the case of those belonging to the Indian Museum, Calcutta.

pm. 4, as may be seen from the size of its alveolus, relatively large. From this precise resemblance there appears to be no doubt that the two specimens belong to the same species; although the second one (a), as may be seen from the following dimensions, is rather smaller than the first (b):—

	V. durandi.			V. zibetha.
	a.	b.		
Width between pm. 4 and m. 1	2.36	2.82	..	1.76
„ at post-orbital processes of frontals	1.68	1.8	..	1.1
„ „ pm. 2	1.15		..	0.88
Interval between alveoli of canine and pm. 4	1.44		..	0.94
Length of alveolus of pm. 1	0.3		..	0.15
„ „ „ „ 2	0.43		..	0.34

The second specimen, although bridging over to some extent the discrepancy in size between *V. bakeri* and *V. durandi*, serves to confirm the conclusions as to their specific distinctness. Thus a comparison of the figures given in the “Fauna Antiqua Sivalensis,” or of the originals in the British Museum, will show that while in *V. bakeri* the facial portion of the skull gradually diminishes in width from the zygoma to the muzzle; in *V. durandi* there is a very sudden contraction in front of the anterior zygomatic root, in advance of which the borders of the maxillæ are nearly parallel. The face of the latter seems also to have been proportionately shorter; while its first premolar is relatively longer than in either the civet or the zibeth.

General characters.—It appears from the foregoing comparisons that *Viverra durandi* is the largest known civet; and in respect of dental characters more nearly allied to the Indian *V. zibetha* and *V. bakeri* than to the African *V. civetta*: presenting in some respects characters intermediate between the two former. In its cranial characters it is markedly distinct from each of the other three species.

Distribution.—Both of the two specimens described above were obtained from the typical Siwalik Hills.

It should be mentioned that a fragment of the mandible, containing one perfect tooth, of a small carnivore from the Siwaliks of Eastern Bengal has been figured by Pentland under the name of *Viverra*.² The specimen is, however, insufficient for generic determination: the tooth is figured by De Blainville.³

FAMILY IV.: HYÆNIDÆ.

This family, according to Professor Mivart,⁴ comprehends the two existing genera *Hyæna* (including *Crocota*), and *Proteles*; but the latter is referred by Prof. Flower⁵ to a distinct family. Professor Gaudry⁶ has established a fossil third genus, under the name of *Hyænictis*; but it will be shown below that there is such a complete transition between that so-called genus and *Hyæna*, that it seems necessary to merge the one into the other; or, at all events, not to rank *Hyænictis* as of more than subgeneric value. A new genus will be described below under the name of

¹ Plate Q, figs. 1, 1a, and 2, 2a.

² “Trans. Geol. Soc. Lon.,” ser. 2, vol. II., pl. XLV., fig. 3.

³ “Osteographie,” Genus *Viverra*, pl. XIII.

⁴ “Pro. Zool. Soc.,” 1882, p. 140.

⁵ *Ibid.*, 1883, p. 186.

⁶ “ Animaux Fossiles et Géologie de l’Attique,” p. 95.

Lepthyana. In the living representatives of the typical genus there is normally but one true molar in either jaw, and each limb carries but four digits. In certain fossil forms (*Lepthyana*, *Hyenictis*), $\overline{m.2}$ is either always, or frequently, developed; while $\overline{m.1}$ is relatively larger than in other species. These forms indicate an approximation to *Ictitherium*, and thus connect the family with the modern civets.¹ The genus *Proteles* is distinguished, among other characters, by the possession of five digits on the anterior limb, and connects the genus *Hyena* with the herpestine division of the preceding family (*Viverridae*).

The family is entirely confined to the Old World, with its head-quarters at the present day in Africa.

GENUS : HYÆNA, Brisson.

Including *Crocotta*, Kaup; *Crocota*, Gray; *Euhyaena*, Falconer, MSS.;

Hyenictis, Gaudry.

Dentition.—The normal adult dental formula of *Hyæna*, in which, for palæontological purposes, at all events, *Crocota*² is best included, is I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{3}$, M. $\frac{1}{1}$. In certain fossil forms, however, $\overline{pm.1}$ is either occasionally, or normally, absent, while in others $\overline{pm.1}$ is normally developed; and in others again $\overline{m.2}$ may be either occasionally, or normally, present. The range of variation in the dentition may, therefore, be expressed by the following formula:—*viz.*, I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{(2-4)}{(3-4)}$, M. $\frac{1}{(1-2)}$. In typical forms the upper true molar is a comparatively small, transversely elongated tooth; but there is considerable variation in the relative size of this tooth in the different species, and in some it is reduced to a minute subcylindrical crown, and may be shed at an early age, even if in some instances it be not totally absent. When fully developed this tooth is generally larger than in the cats, though occupying a similar position: in typical forms it is different from the corresponding tooth in the dogs, which is always placed behind, instead of internally to, $\overline{pm.4}$. The latter is a large tooth, which by the great development of the anterior talon has acquired a distinctly trilobed blade. In describing this tooth it will be convenient to refer to these three lobes as first, second, and third lobe, but it must always be remembered that the first lobe is unrepresented in the carnassial of the dogs, and corresponds to the talon-lobe of *Hyænarcos* (plate XXX., fig. 2, a). The second, or middle, lobe corresponds to the first lobe of the dog's tooth (*Hyænarcos*, *m*); and the third, or last, lobe, to the second or last lobe of the dog's tooth (*Hyænarcos*, *p*). This tooth is generally distinguished from the carnassial of the cats by the larger size of the tubercular portion; but there is one species (*H. eximia*) in which this is small, and the distinction from the feline tooth is then very slight. The second and third upper premolars are large sub-conical teeth, with or without talons: the great development of the main lobe of these teeth in the typical forms distinguishing them from the corresponding teeth of the cats and dogs. The first

¹ See Gaudry, "Les Enchaînements du Monde Animal, etc.—Mammifères Tertiaires," p. 215, *et. seq.*

² Considered distinct by Prof. Mivart, *op. cit.*

upper premolar is a much smaller tooth, with a general resemblance to the corresponding tooth of the dogs.

In the lower jaw the carnassial ($\overline{m.1}$) is divided into a blade and talon, the latter bearing two small cusps: the lobes of the blade are large and subequal; in the less specialized forms (*H. striata*) there is a small inner cusp to the hinder lobe, but this disappears in the more specialized forms. The presence of the talon to $\overline{m.1}$ distinguishes it from the corresponding tooth of the modern cats: but this part varies in size in the different species, being relatively small in the more specialized forms. The lower premolars are conical teeth, varying considerably in the amount of lateral compression, and in the degree of development of their fore-and-aft talons. The first lower premolar, when present, is always small.¹

Distribution.—Both in the living and fossil state the hyænas are essentially Old World forms, no traces of them having ever been found in America.² The living forms are found in India, Persia, Asia Minor, and North and South Africa, and the fossil representatives of the genus have been found in Europe, North Africa, India, and China. The genus is unknown before the epoch of the Pikermi beds.

Number of species.—The following list comprizes the best known species of the genus, exclusive of the Indian fossil species, with their more important synonymy. Doubtful species are indicated by an asterisk.

- *1. *HYÆNA ANTIQUA*,³ Lank. Up. pliocene, England.

A very doubtful provisional species, founded upon a single $\overline{pm.3}$: is said to be allied to *H. striata*.

- *2. *HYÆNA ARVERNENSIS*, Cr. and Job. Up. pliocene, Europe.

This form is closely allied to, if not identical with, the living *H. striata*, with which it is provisionally associated by Professor Gaudry.⁴

3. *HYÆNA BREVIROSTRIS*, Aymard. Pliocene, Europe.

This species is distinguished from all others by its gigantic size: the lower carnassial has a large talon, but no inner tubercle: the upper true molar is very large.

4. *HYÆNA BRUNNEA*, Thunb. Recent, South Africa.

H. fusca, G. St. H.

H. villosa, Smith.

Crocuta brunnea, Gray.

In this species the lower carnassial has a small talon, with normally a small inner cusp, but this may be absent.⁵ the upper true molar is very large. One instance is recorded of the absence of the latter tooth.⁶ There is a distinct anterior talon to $\overline{pm.3}$, but this is smaller than in *H. striata*: the third lobe of $\overline{pm.4}$ is not larger than the middle.

5. *HYÆNA CHÆRETIS*,⁷ Gaud. and Lart. Pikermi beds, Greece.

This species is distinguished by the elongated form of its premolars: the lower carnassial has a large talon, and inner cusp: the upper true molar is unknown, and $\overline{pm.1}$ present.

¹ For a more detailed description of the dentition of the existing forms see Mivart, 'Pro. Zool. Soc.,' 1882, p. 199, et. seq., and Busk, 'Journ. Linn. Soc.—Zoology,' vol. IX., 1866, p. 69.

² The so-called *Hyæna neogaea* of Lund=*Machærodus*. ³ 'Ann. Mag. Nat. Hist.,' vol. XIII., 1864, p. 56, pl. VIII.

⁴ 'Animaux Fossiles et Géologie de l'Attique,' p. 103.

⁵ College Surg. Museum, No. 519.

⁶ Mivart, 'Pro. Zool. Soc.,' 1882, p. 200.

⁷ Gaudry, 'Animaux Fossiles et Géologie de l'Attique,' p. 92, pl. XV.

6. *HYÆNA CROCUTA* (Erxl.). Pleistocene, Europe; Recent, S. Africa.*H. capensis*, Desm.*Crocota maculata*, Kaup.*H. maculata*, Thunb. (non Odm.)*C. spelæa*, Kaup (? var.)*H. rufa*, Cuv.*Crocota maculata*, Gray.*H. spelæa*, Goldf. (? var.)*Canis crocuta*, Erxl.

In this species $\overline{m.1}$ has a small talon, and no inner cusp¹; $\overline{m.1}$ is always minute, and may possibly be absent in some instances²; it has either one or two fangs. In one skull³ there is on one side the alveolus of a minute $\overline{m.2}$. The hinder lobe of $\overline{pm.4}$ is larger than the middle; and there is no distinct anterior talon to $\overline{pm.3}$, which is set parallel to the molar alveoli.

7. *HYÆNA EXIMIA*,⁴ Roth. and Wagner. Pikermi beds, Greece and Hungary.*Hyæna hipparionum*, Suess (non Gerv.) in parte.

In this species $\overline{m.1}$ has a large talon, but no inner cusp: $\overline{m.1}$ is large: $\overline{pm.1}$ is present; and in one specimen⁵ $\overline{pm.1}$ is absent. $\overline{pm.3}$ has no anterior talon; and in $\overline{pm.4}$ the tubercle is very small, and the third lobe slightly larger than the second.

8. *HYÆNA GRÆCA*⁶ (Gaud.) Pikermi beds, Greece.*Hyænitis græca*, Gaud.*Hyæna hipparionum*, Suess (non Gerv.) in parte.

In this species $\overline{m.2}$ is present, and $\overline{m.1}$ very large: $\overline{m.1}$ has a large hind talon, and no inner cusp; the tubercle of $\overline{pm.4}$ is large, as is apparently its third lobe.

*9. *HYÆNA PERRIERI*,⁷ Cr. and Job. Up. pliocene, Europe.

In this form the lower carnassial has a large talon, but no inner tubercle: the upper true molar is of medium size. It is probable that it is closely related to, if not merely a variety of, *H. crocuta*.⁸

*10. *HYÆNA SINENSIS*,⁹ Owen. Pliocene or pleistocene, China.

This species, founded on the evidence of an upper and lower third premolar, is not improbably the same as one of the Siwalik species described below.

11. *HYÆNA STRIATA*, Zimm. Pleistocene, S. Europe; Recent, India, Persia, Asia Minor, and N. Africa.*H. antiquorum*, Tem.*H. prisca*,¹¹ M. de Scr.*H. fasciata*, Thunb.*H. veterum*, Kämpfer.*H. intermedia*,¹⁰ M. de Scr.*H. virgata*, Gray.*H. monspessulana*, Christ.*H. vulgaris*, Desm.*H. orientalis*, Tiedm.*Euhyaena striata*, Falc.*Canis hyæna*, Lin.

In this species the lower carnassial has a large talon and inner cusp, and the upper true molar is large: there are large fore-and-aft talons to $\overline{pm.3}$, and the third lobe of $\overline{pm.4}$ is not larger than the second.

The so-called *Hyæna hipparionum*, of Gervais, is the same as *Ictitherium*; while *Hyæna neogæa*, of Lund, as already mentioned, is a *Machærodus*.

¹ Traces of this cusp may occasionally exist, especially in the fossil race. See Busk, 'Trans. Zool. Soc.', vol. X, p. 77.

² *Ibid.*, p. 78.

³ Museum of Royal College of Surgeons, No. 523

⁴ Gaudry, "Animaux Fossiles et Géologie de l'Attique," p. 80, pls. XII.-XIV.

⁵ Cast in British Museum.

⁶ Gaudry, *op. cit.*, p. 95, pl. XV.

⁷ Blainville, "Ostéographie," Genus Hyæna, pls. VI.-VIII.

⁸ Boyd Dawkins, 'Nat. Hist. Rev.', 1865, p. 80, *et. seq.* In subsequent memoirs ('Quart. Journ.', vol. XXVIII., p. 443, 'Cave Hunting,' p. 421) Mr. Dawkins identifies this species with *H. striata*, and says that Professor Gaudry agrees with him. This is probably altogether an error, as Professor Gaudry classes *H. perrieri* with *H. crocuta* in his "Animaux Fossiles et Géologie de l'Attique," p. 103.

⁹ "Quart. Journ. Geol. Soc.," vol. XXVI., p. 422, pl. XXVIII, figs. 5-7.

¹⁰ *teste* Busk, 'Zool. Trans.,' *op. cit.*

¹¹ *teste* Gervais, "Zool. et Pal. Franç.," p. 241.

The best known of these species may be classed as follows, mainly after Prof. Gaudry, *viz.* :—

	m.1	pm.1	m.1		m.2
			cuspid	talons	
<i>H. erocuta</i> (inner cusp absent in $\overline{mm.4}$) .	small	absent	absent	small	absent
<i>H. porrieri</i>	"	"	"	"	"
<i>H. eximia</i> (tubercle of $\overline{pm.4}$ very small) .	large	present	"	large	"
<i>H. brevisrostris</i>	"	?	"	"	"
<i>H. græca</i> (inner cusp present in $\overline{mm.4}$) .	very large	present	"	"	present
<i>H. brunnea</i> (inner cusp of $\overline{m.1}$ small) .	large	absent	present	large	absent
<i>H. arvernensis</i> (inner cusp of $\overline{m.1}$ large) .	very large	"	"	very large	"
<i>H. striata</i> " " " " " .	"	"	"	"	"
<i>H. cheretis</i> (premolars elongated) .	?	present	"	"	?

Species 1: *HYÆNA FELINA*, Bose.

Syn. *H. sivalensis*, Falc. and Caut., in part. (?) *H. sinensis*, Owen.

History of Siwalik hyænas.—Before describing the remains assigned to the present species, it will be well to give a brief *resumé* of the previous history of Siwalik hyænas. The earliest notice of the remains of hyænas from the Siwaliks, appears to be one in 1835, by the late Gen. (then Lieut.) Sir W. E. Baker,¹ in which a skull with the mandible attached (now in the Science and Art Museum, Dublin) is described and figured. No specific name was assigned to the specimen, which was stated to be more nearly allied to the fossil hyæna of Europe (*H. erocuta*), than to the existing Indian species. It was incidentally mentioned that other Siwalik specimens discovered by Colonel Colvin (now in the Indian Museum) probably indicated a second species. In 1847, Dr. Falconer, in a letter to De Blainville,² made mention of two species of Siwalik hyænas. In 1859, two crania of Siwalik hyænas (those discovered by Colonel Colvin), then in the collection of the Asiatic Society of Bengal, were catalogued by Dr. Falconer,³ without the affix of any specific name. In the "Palæontological Memoirs" (1868) descriptions of three of the unpublished plates (K.L.M.) of the "Fauna Antiqua Sivalensis," containing figures of the remains of Siwalik hyænas in the British Museum, are given. It happened, however, by mistake, that the first of these plates (K), containing figures of the skulls, was lettered *Felis cristata*. The other two plates were lettered *Hyæna sivalensis*, Falc. and Caut., but in the description of the first (L) it is observed⁴ "this species, however, is no doubt that designated *Hyæna sivalensis* by Messrs. Baker and Durand in the brief description given by them in the "Journal of the Asiatic Society" for October, 1835, Vol. IV, p. 569." In regard to that observation, it has been already observed that the author of that paper (Sir W. E. Baker alone), did not assign any specific name to his specimen. The name *Hyæna sivalensis*, if ever given at all by Falconer and Cautley, must have only existed in manuscript notes, from which

¹ "Journ. Asiat. Soc., Beng.," vol. IV, p. 569, pl. XLVII, figs 22-3.

² "Pal. Mem." vol. I, p. XXI.

³ *Ibid.* p. 343.

⁴ *Ibid.* pp. 548-9.

the descriptions in the "Palæontological Memoirs" were compiled; and as it is impossible to determine to how many of the British Museum specimens it was intended to apply, it seems best, as far as Dr. Falconer is concerned, that this name should be dropped. In plate XXV, of the same volume of the "Palæontological Memoirs," one of the Siwalik hyæna skulls is refigured under the erroneous designation of *Felis cristata*. In 1880, Mr. P. N. Bose, now of the Geological Survey of India, described¹ two Siwalik hyæna skulls, and some mandibles, in the collection of the British Museum, and assigned them to distinct species, with the names of *H. sivalensis*, Falc. and Caut., and Bose; and *H. felina*, Bose. In a notice of that paper the present writer² compared these descriptions with the teeth of three Siwalik hyæna skulls in the Indian Museum, and came to the conclusion that certain dental characters, mainly relied upon by Mr. Bose, were not of themselves of sufficient value to justify specific distinction; the five specimens were accordingly provisionally referred to *H. sivalensis*, Falc. and Caut.; the authenticity of the name not then forming a part of the enquiry. To this notice Mr. Bose replied,³ maintaining his original views, upon which the present writer once more advocated his own opinion.⁴ The views of Mr. Bose as to the existence of two species were mainly based upon the minute size of m. 1 in one species (*H. felina*), and its large size in the other (*H. sivalensis*); the former being also characterized by the absence of pm. 1. The present writer showed that in the former character there was such a gradual transition between the different skulls that it was difficult to see how they were to be referred to the two species of Mr. Bose.⁵ Mr. Bose, neglected to avail himself of many of the specimens in the collection of the British Museum, which if carefully described, would have established his two species beyond all possibility of cavil; and the dental characters relied upon by him in his distinction of *H. felina* are not the most important, while one of them is inconstant.

Now that an opportunity has been afforded of comparing together all the known remains of Siwalik hyænas, contained in the collections of the British, Indian, and Dublin Museums, it appears that they indicate the existence of certainly four, and possibly five species of Siwalik hyænas; for two of which, the names proposed by Mr. Bose are retained, although one of them is somewhat objectionable.⁶

It might at first sight appear extraordinary that so many species of hyæna should have formerly existed contemporaneously in India, but when the large number of species of Proboscidea and other ungulate forms that existed at the same time, is recalled to memory, it is perhaps only what might have been expected to find the genera of the Carnivora equally strongly represented in species.

¹ "Quart. Journ. Geol. Soc.," vol. XXXVI, p. 128, *et seq.*

² "Rec. Geol. Surv. Ind.," vol. XIV, p. 62.

³ *Ibid.*, p. 266.

⁴ *Ibid.*, vol. XV, p. 28.

⁵ It is unnecessary to refer to certain mutual misunderstandings in regard to the identification of the specimens.

⁶ The writer now regrets that he published criticisms on Mr. Bose's work, without first seeing the original specimens on which it was based.

With these preliminary observations the description of the remains of *H. felina* may be commenced.

Type cranium.—The cranium on the evidence of which the species *H. felina* was founded by Mr. Bose, is in the British Museum (No. 15,902), and was obtained from the Siwaliks by Mr. W. Ewer. It is figured ($\frac{1}{2}$) in plate K, figs. 1, a, b, c, of the supplemental plates of the "Fauna Antiqua Sivalensis," where as mentioned, it is erroneously named *Felis cristata*. The left maxilla is, however, wanting in all those figures, since that part of the specimen was discovered after they were drawn. In his memoir, Mr. Bose has figured the complete palate of this specimen ($\frac{1}{1}$), and as this figure is excellent and easy of access, it has been thought unnecessary to repeat it here. According to Mr. Bose, this specimen "is deficient only in the zygomatic arches, and evidently belongs to an aged individual. The facial portion has suffered a crush anteriorly, and is slightly distorted in consequence. The incisors have been removed. The crown of the canine has been broken off, but its base shows it to have been proportionately stronger than the corresponding tooth of *Hyæna* [*sic*]; this, however, may be an individual variation. There is *no indication whatever*, of the presence of premolar 1, which is so constant in all known species of *Hyæna*, living or fossil; and the canine is separated by a short diastema from premolar 2 (first of the molar series in the fossil). This tooth is two-fanged and resembles the corresponding tooth of *Hyæna* in its dimensions, as may be judged by its base, the crown being broken off. The second false molar too (pm. 3) is in form and size hyænoid. The sectorial [carnassial] is proportionately larger than in the living Indian *Hyæna*, and is provided with a very strong and stout internal tubercle. The alveolus of the tubercular molar [m. 1], preserved on the right side, is situated as in the *Felidae*, and shows that tooth to have been transverse and *exceedingly small*, thus differing from *H. striata* and *H. sivalensis*. The sagittal crest is very prominent and quite *Hyæna*-like, gently sloping on the sides; but the occipital crest is proportionately higher than in any other species of *Hyæna*. The specific name given to the fossil is based on the approach it makes to feline organization, especially in the entire absence of premolar 1 from the upper jaw."

The lateral crush to which the specimen has been subjected, renders it difficult to form an exact estimate of the proper width of the hinder part of the palate; and the same crush has caused the profile of the face ("F.A.S." pl. K, fig. 1, b) to be nearly straight, in place of concave. The whole form of the skull and dentition shows that the specimen belonged to a true and typical hyæna, and Mr. Bose might have spared himself the pains of comparing its m. 1 with that of the *Felidae*, with which it presents not the slightest affinity: the form of the alveolus shows, indeed, that the complete tooth must have been like the corresponding tooth of *H. crocuta*, although not quite so minute as in some individuals of that species. It agreed with the latter, and thereby differed from the corresponding tooth of all other hyænas, except *H. perrieri*, in being either uni— or bi— in place of tricuspid.

In general form this skull is very like that of *H. erocuta*, but is distinguished by the more backward prolongation of the occipital crest behind the condyles ("F.A.S.," pl. K, fig. 16), and the more regular triangle formed by the boundaries of the occipital surface: in both of which respects it shows affinity to *H. striata*.¹

The cheek-teeth are very much worn, indicating the extreme age of the animal; and have also been much battered about: it appears, however, that there is no large anterior talon to pm. 3, and the crown of the carnassial is relatively low, with the inner tubercle proportionately large: this tooth is, however, long in proportion to the earlier premolars, and the position of the summit of the middle lobe (*well shown in Mr. Bose's figure*) indicates that the hindmost lobe was relatively large, as in *H. erocuta*. The diminutive size of m. 1 allies the skull more closely to the last-named species than to any other; and taking into account the constancy of the size of this tooth in the latter, which according to Professor Busk never exceeds 0.2 or 0.21 in its transverse diameter, it is probable that the minuteness of this tooth should be considered characteristic of the fossil. With regard to the absence of pm. 1, which will however, be shown to be present in another specimen, it has been mentioned that there is one instance of the absence of this tooth in *H. eximia*, but in that case, the canine is not approximated to pm. 2, as in the specimen under consideration, and it may, therefore, be considered probable that the approximation of pm. 2 and the canine is another characteristic of the species under consideration. The dimensions of this skull will be given after describing the next specimen.

Dublin cranium.—In the accompanying woodcut (fig. 13) two views are given of the cranium described by Sir W. E. Baker, already referred to, and now in the Museum of Science and Art, Dublin.² The specimen is described "as the most perfect fossil we have yet been so fortunate as to meet with. It appears to have been enclosed in the stratum with the lower jaw in position but not quite closed. The only injuries which it has sustained are the loss of its left zygomatic arch, a slight displacement of the [same] half of the lower jaw, of which the canine tooth is broken off near its base, and the mutilation of the occiput, which is perhaps the greatest loss of all.

"The skull must have belonged to a full-sized animal, as some of the molars are worn flat on the tops; it is smaller than Cuviers' fossil *Hyæna* [*H. erocuta*], and somewhat different, though having a much near resemblance to it than to the existing hyæna of the country [*H. striata*]." Since this description was written the specimen has suffered the loss of the right zygoma, and of the left upper carnassial; but it is otherwise in very good preservation, and, with the above-mentioned exceptions, exhibits the whole of the dentition, although only the outer surface of most of the teeth are visible, and m. 1 is totally concealed. In the

¹ See Busk. "Zool. Trans.," *op. cit.*, p. 78.

² This was one of the specimens purchased by the Museum from Dr. Beatty; it is numbered, 42.

following table, its dimensions are compared with those of the type skull of *H. felina* and of skulls of *H. crocuta*, and *H. striata*. The fossil skull of *H. crocuta* is a specimen in the British Museum (No. 28,577); the recent in the Royal College of Surgeons (No. 523). The skull of *H. striata* is an unusually large specimen in the

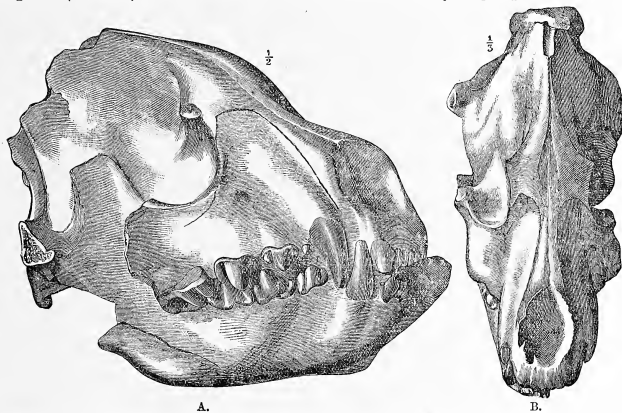


Fig 13. *Hyena felina*, Bosc. Cranium from the Siwaliks: Science and Art Museum, Dublin. A., oblique view of right side, $\frac{1}{2}$; B., front view, $\frac{1}{2}$.

writer's possession. The numbers in brackets are means taken from the tables accompanying Professor Busk's memoir in the "Journal of the Linnean Society," already quoted.

	H. felina		H. crocuta		H. striata
	Type	Dublin	Fossil	Recent	
Width of palate at pm. 4	4.3 (?)	4.6 (?)	4.8	4.15	3.5
" " 3	3.9 (?)	4.1	4.5	4.0	3.22
" " behind canine	2.5	2.66	2.82	2.42	2.0
" " at "	2.6	2.72	2.84	2.46	2.14
Interval between posterior border of palate and anterior border of incisive alveoli	4.7		5.48	4.9	4.74
Interval between inferior border of foramen magnum and the same	8.15	9.1	9.2	9.15	8.4
Interval between postorbital process of frontal and the same	5.3	5.6	5.42		4.9
Ditto between same and posterior border of occipital condyle	4.9	5.4		6.06	5.12
Space occupied by incisors	1.75	1.81	1.72	1.5 (1.49)	1.25 (1.27)
Interval between canines	1.55		1.69	1.6	1.2
" " hinder border of pm. 4 and canine	3.14	3.3	3.64	3.4	2.87
Length of 3 last premolars	2.82	3.04	3.21	2.8	2.55
" 4		3.2	3.46	(3.33)	2.79 (2.71)
Interval between canine and pm. 2	0.24	0.3	0.42	0.55	0.42
Length of pm. 1		0.24	0.28	0.25 (0.3)	0.29 (0.23)
" " 2	0.67	0.72	0.72	0.6 (0.67)	0.68 (0.62)
" " 3	0.85	0.86	0.99	0.88 (0.94)	0.88 (0.8)
" " 4	1.37	1.5	1.59	1.48 (1.46)	1.2 (1.17)
Transverse diameter of m. 1	0.22 (?)		0.2	0.2 (0.2)	0.58 (0.5)
Antero-posterior diameter of canine	0.75	0.76	0.84	0.75 (0.76)	0.68 (0.61)
" " incisor 3		0.58	0.59	0.51 (0.52)	0.41 (0.39)

These dimensions show that while the Dublin skull is about one inch longer than the type of *H. felina*, its dimensions are proportionately almost precisely the same, and as the two skulls agree in general form and characters, it is practically certain that they belong to the same species;—a conclusion which will be confirmed by the characters of the teeth and mandible: it is probable that the smaller skull should be regarded as that of a female, and the larger as that of a male. The dimensions show that the proportions of the fossil skulls are very similar to those of *H. crocuta*; the fossil race of the latter being rather larger than the Dublin skull: the dimensions of *H. striata* differ considerably.

With regard to the dentition of the Dublin skull, it will be seen from the figure that this differs from the type specimen by the presence of pm. 1; the two agree, however, in the smallness of the interval between the canine and pm. 2. The latter tooth has a large hind talon, and a smaller fore talon. In pm. 3 there is also a large hind talon and a smaller fore talon; and the crown of the tooth is set obliquely to the axis of the molar alveoli. In pm. 4 the hind lobe is larger than either of the others; the respective lengths being, fore lobe 0·38, middle 0·45, hind 0·6. In this respect the tooth agrees with *H. crocuta*, but the first lobe is relatively longer, the corresponding dimensions in a tooth¹ of the fossil race of that species measuring 1·6, being 0·38, 0·58, and 0·8.

Maxilla.—In figures 2, and 2a, of plate XXXV, A, of the present volume, there is represented a part of the right maxilla of a Siwalik hyæna², in the British Museum (No. 37,138), showing the last premolars; the summits of the first and second lobes of pm. 4 have been broken away, and the summit of pm. 3 is somewhat abraded by wear, showing that the specimen belonged to a fully adult individual. At the hinder end of the carnassial, there may be seen in the bone (though this could not be displayed in the figure) the fang, or fangs, of a minute m. 1. A comparison of this specimen with the Dublin skull, has shown that the two agree so closely in size and general form that there is every probability that they may be referred to the same species. The condition of the teeth of the isolated maxilla allows of a more complete examination than in either of the two skulls. In the following table the dimensions of the teeth of the two latter are compared with those of the specimen under consideration.

	No. 37,138.	Dublin specimen.	Type.
Length of 3 last premolars . . .	3·18	3·04	2·82
„ „ <u>pm. 2</u> . . .	0·76	0·72	0·67
„ „ <u>3</u> . . .	0·94	0·86	0·85
„ „ <u>4</u> . . .	1·55	1·5	1·37

It will be seen that the teeth of the detached maxilla are slightly larger than those of the Dublin skull. The carnassial of the former agrees with that of the latter, in being a modification of the crocutine type; having a larger fore lobe and a lower crown than in *H. crocuta*, but a similarly large tubercle, extending as

¹ A specimen from the Forest-bed figured by Mr. E. T. Newton in 'Geol. Mag.,' 1883, pl. X.

² This specimen is figured in plate L (letter), figs. 8, 8a, of the "Fauna Antiqua Sivalensis," from which pl. XXXV, A is copied; the figures being reversed.

far forwards as the blade,—a character of *H. crocuta*, as distinguished from *H. striata* and *H. brunnea*. Pm. 3 has likewise a relatively low crown, and a markedly convex external vertical contour: it is set obliquely to the molar alveoli, with its hinder end obliquely truncated, and has a well-marked hind talon, and an indistinct fore one¹; there is a fairly distinct vertical ridge at the hinder border of the crown, but none anteriorly: and no trace of a cingulum on the outer surface, and no distinct one internally. Pm. 2 is a long narrow tooth, with small but distinct fore-and-aft talons; the latter being considerably the larger of the two. It is impossible to say whether pm. 1 existed in this specimen.

Characters of upper cheek-teeth.—In regard to its upper cheek-teeth, it may be affirmed of the species to which the foregoing specimens belonged, that it differed both from *H. striata*, and *H. brunnea*, in having the 3rd lobe of pm. 4 relatively large; and in the small size of m. 1: It also differed from the former by the smaller development of the talons of pm. 2 and pm. 3: and from both by the less oblique position of these teeth, and the absence in them of a distinct cingulum. There is, therefore, apart from the cranial differences, no doubt that this form is specifically distinct from either of the others.

The teeth agree more nearly with those of *H. crocuta* in respect of the form of pm. 4 and m. 1; but are distinguished by the less specialized character of the former, and by the crown of pm. 3 being relatively lower, and its excess in height over pm. 2 less marked; its hind talon is also relatively larger: pm. 2 is both longer and narrower: while the long axes of these teeth are continuous, in place of forming a well-marked angle at their junction.² Pm. 3 is further distinguished by being set somewhat obliquely to the molar alveoli; and by the absence of a ridge at its antero-internal angle, which is more or less distinctly marked in *H. crocuta*. Further comparisons will be instituted after the description of the mandible.

Third upper incisor.—In figure 3, of plate XXXV, there is represented the third left incisor of a large hyæna, obtained by Mr. Theobald, from the Siwaliks of Asnot, not improbably belonging to the present species. The antero-posterior diameter of the base of the crown is 0·66; or somewhat larger than that of the corresponding tooth of the Dublin cranium. All the other Siwalik hyænas have smaller incisors. The cingulum on the inner side of the specimen is very slightly developed.

Mandible of Dublin specimen.—In the Dublin specimen (woodcut fig. 13) the mandible is fairly complete, and of the normal hyænine form. As in all the existing species, pm. 1 is absent, but the interval between the canine and pm. 2 is, as in the upper jaw, relatively small. Regarding the other teeth, pm. 2 has a minute fore³ and a large hind talon; pm. 3 has no distinct fore, but a large hind talon; while in pm. 4 there are both large fore-and-aft talons, the latter being the

¹ The talons in the Dublin skull appear slightly more developed than in the present specimen. This character is, however, exaggerated in the figure, owing to the former being viewed obliquely, and the latter directly from the outer side.

² See De Blainville "Ostéographie," Genus Hyæna, pl. III (palate of *H. crocuta*).

³ The obliquity of the figure causes this talon to appear much larger than it really is.

larger. The carnassial ($\overline{m.1}$) has a relatively small hind talon, as in *H. crocuta*, but its inner surface is not exposed. The dimensions of this specimen will be given below.

Indian Museum mandible.—In figures 1, of plates XXXVIII., XXXIX., of this volume, there are given two views of the left ramus of the mandible of a large hyæna collected by Mr. Theobald in the topmost Siwaliks of the Jamu district, and now in the Indian Museum (No. D, 102). This specimen belonged to an adolescent animal, the permanent canine (c) not being fully protruded. In respect of form and dentition, this specimen agrees with the Dublin mandible, with the exception of being somewhat larger; but this character cannot be regarded as more than an individual variation. It has the same general proportions as a fossil jaw of *H. crocuta* figured by Prof. Gaudry,¹ but is distinguished by the depth of the horizontal ramus being more uniform throughout its length, in place of being considerably greater behind the carnassial than below the premolars: $\overline{m.1}$ is almost indistinguishable from the corresponding tooth of the spotted hyæna; the inner cusp being absent, and the talon relatively small. $\overline{pm.4}$ is nearly as large as $\overline{m.1}$, and has large fore-and-aft talons. In $\overline{pm.3}$ there is a large hind, but no fore talon; but there is a slight trace of the latter in $\overline{pm.2}$: $\overline{pm.1}$ is absent. Owing to the incomplete protrusion of the canine, it is difficult to precisely estimate the exact length of the 'diastema,' but this appears to have been relatively small. The dimensions of this specimen will be given below.

British Museum mandible.—In his description of *H. felina*, Mr. Bosc did not refer any mandible to that species. There is, however, in the British Museum, the greater part of a mandible (No. 16,565), represented in figures 2, 2a, of plate XXXIX., of the present volume,² which in respect of size, of the condition of the wear of the teeth, and its state of petrification agrees so closely with the type skull of *H. felina*, that there is every probability that the two belonged to the same species, and a very strong one that they belonged to the same individual. At least the former probability is converted into a certainty by the fact that, except as regards its somewhat smaller size, this specimen agrees in every respect with the two mandibles described above. It belongs to the right side of the jaw, and shows the whole of the hinder part of the ramus, with the three last teeth—all much worn and battered: it is fractured in front of $\overline{pm.3}$, the fracture having involved a part of that tooth, and extending inferiorly backwards as far as the middle of $\overline{pm.4}$. Even in its present battered condition, the specimen shows that $\overline{m.1}$ was a relatively large tooth, having a small hind talon, and no inner cusp. The other teeth are too much damaged for exact description, but the side view shows that $\overline{pm.4}$ had well-developed fore-and-aft talons.

In the following table the dimensions of the three mandibles described above are compared with those of the three existing species of hyæna; the latter being

¹ "Materiaux pour l'Histoire des Temps Quaternaires," Paris (in course of publication) pl. IV, fig. 8.

² Also in figs. 1, 1a, of plate M of the "F.A.S."

the means given by Professor Busk in the memoir already quoted.

	H. felina.			H. crocuta.		H. brunnea.	H. striata.
	Brit. Mus. 16,565	Dublin skull	Ind. Mus. D, 103	Fossil	Recent		
Length of last three cheek-teeth	2.75 (?)						2.35
" series of		3.18	3.7	3.52	3.4	3.09	2.68
" pm. 2		0.65	0.78	0.66	0.63	0.62	0.52
Width " "			0.54	0.48	0.44	0.45	0.32
Length " 3		0.85	1.03	0.89	0.85	0.84	0.72
Width " "	0.55		0.65	0.65	0.6	0.55	0.5
Length " 4	0.85	0.92	1.1	0.95	0.91	0.94	0.78
Width " "	0.55		0.76	0.69	0.52	0.53	0.48
Length " m. 1	1.0	1.05	1.22	1.2	1.2	0.94	0.81
Width " "	0.5		0.67	0.55	0.5	0.5	0.4
Depth " jaw at m. 1	1.73	1.75	1.86	2.2	1.64	1.63	1.39
Interval between canine and pm. 2		0.4	0.4		0.37	0.41	0.45

These dimensions indicate that the mandible in the Indian Museum belonged to an animal larger than the pleistocene race of *H. crocuta*; while the British Museum specimen indicates an animal of about the mean size of the living race of that species. The premolars of the fossil are larger in proportion to $\overline{m.1}$ than in *H. crocuta*.

Regarding the affinities indicated by the lower cheek-teeth of this Siwalik hyæna it has been shown that $\overline{m.1}$ is essentially crocutine, and, therefore, perfectly distinct from the corresponding tooth of *H. striata* and *H. brunnea*. The premolars have a considerable general resemblance to those of *H. crocuta*, but are distinguished by their relatively lower crowns, and the more marked ridges at their fore-and-aft borders, this character being most noticeable in the anterior ridges; they are also, as mentioned, larger in proportion to $\overline{m.1}$; while the hind talon of $\overline{pm.3}$ and the anterior talon of $\overline{pm.4}$ are relatively larger; and $\overline{pm.2}$ is altogether relatively longer.

Other specimens.—In figures 5, 5a, of plate M. of the "F.A.S.," there is represented part of the left ramus of the mandible of a Siwalik hyæna in the British Museum (No. 39,731), apparently agreeing in all essential characters with the specimens described above¹: it shows the base of the canine, the second and third premolars, the base of the fourth tooth of the same series, and $\overline{m.1}$. The latter is of the crocutine type, and the premolars appear to agree with those of the jaws described above; the squared form of $\overline{pm.3}$ is well shown in this specimen.

In figure 3 of plate XXXIX. of the present volume there is represented the dental aspect of a fragmentary mandible of a Siwalik hyæna, formerly in the collection of the Asiatic Society of Bengal, and now in the Indian Museum (No. D. 50). In the catalogue of the society's fossil collection by Drs. Falconer and Walker² it bears the number S. 849, and is described as "a fragment of lower jaw, right side, containing the four molars *in situ*: teeth larger than in the existing [?] Indian Hyæna, but a good deal concealed by matrix." The teeth have now been cleared of matrix,

¹ This specimen, together with the one (B. M. No. 37,140), represented in figures 7, 7a, of the same plate, is referred by Mr. Bose ('Quart. Journ. Geol. Soc.,' *op. cit.*, p. 128), to his *Hyæna sivalensis*: it will, however, be shown in the sequel that the mandible of that species is of quite a distinct type.

² p. 189; see also "Palæontological Memoirs," vol. I., p. 343.

and consist of $\overline{\text{pm. 3}}$, $\overline{\text{pm. 4}}$, and $\overline{\text{m. 1}}$, the talon of the latter being still concealed by matrix: the base of $\overline{\text{pm. 2}}$ is also shown. In the following table the dimensions of this and the last specimen are compared with those of the three typical mandibles of *H. felina*:—

	Brit. Mus., 39,731	Ind. Mus., D. 50	Brit. Mus., 16,565	Dublin skull	Ind. Mus., D. 102
Length of series of cheek-teeth	3.1	3.18		3.18	3.7
„ „ $\overline{\text{pm. 2}}$	0.59	0.62		0.65	0.78
Width „ „ „	0.36	0.42			0.54
Length „ „ 3	0.75	0.75		0.85	1.03
Width „ „ „	0.54	0.54	0.55		0.65
Length „ „ 4		0.82	0.85	0.92	1.1
Width „ „ „		0.50	0.55		0.76
„ „ $\overline{\text{m. 1}}$	1.04	1.01	1.0	1.15	1.22
Depth at „ „	1.56	1.73	1.73	1.75	1.86
Interval between canine and $\overline{\text{pm. 2}}$	0.39			0.4	0.4

The gradations in these measurements are such that no distinctions on this score can be drawn between any of the specimens. In D. 50 $\overline{\text{pm. 4}}$ is relatively narrower, and the cingulum on the inner side of the hind talon more marked than in D. 102. The squared form of $\overline{\text{pm. 3}}$ is very constant in all the specimens in which it can be well observed; and it seems advisable to provisionally refer all the five specimens to the same species, although there may be some doubt with respect to D. 50.

The specimen of an immature mandible of a Sivalik hyæna represented in figures 7, 7a of plate M. of the "F.A.S." (B. M. No. 37,140),¹ and also the specimen of a distal extremity of a mandible represented in figures 3, 3a of the same plate (B. M. No. 16,584), may not improbably be referred to the present species.

Distinctness and affinities.—Summing up the results of the foregoing descriptions and comparisons it will be apparent that *H. felina* is more nearly allied to *H. crocuta* than to either of the other existing hyænas; but is readily distinguished by the different form and position of the upper premolars, the larger size of $\overline{\text{pm. 4}}$ and its talons, the form of the occiput, the occasional absence of $\overline{\text{pm. 1}}$, and the approximation of the canine and $\overline{\text{pm. 2}}$. In those points in which it differs from *H. crocuta* it makes a step in the direction of the less specialized *H. brunnea* and *H. striata*; from both of which it is, however, in most respects widely different.

With regard to the extinct species mentioned in the list on pp. 276-7, if the small size of $\overline{\text{m. 1}}$ be constant in *H. felina*, the only species (besides *H. crocuta*) with which it could be closely allied would be *H. perrieri*, which is probably the same as *H. crocuta*, and, therefore, differs from *H. felina* in the same points as the latter. If, however, the small size of $\overline{\text{m. 1}}$ be not constant in *H. felina*, that species might be

¹ This specimen has been referred to the *Felidae*; see "Paleontological Memoirs," vol. 1., p. 549.

allied to *H. eximia* and *H. brevirostris*. From the former, and probably also from the latter, it is broadly distinguished by the large size of the inner tubercle of pm. 4; the absence of an outer cingulum to pm. 3 and m. 1; the larger size of the anterior talon of pm. 4; and the absence of pm. 1. *H. græca* is sufficiently distinguished by the presence of pm. 1 and m. 2, and the large size of m. 1.

The third upper premolar of *H. antiqua*, of the Red Crag, is said to indicate relationship to *H. striata*; and the former species is, therefore, unlikely to be allied to *H. felina*.

With regard to *H. sinensis*,¹ described upon the evidence of specimens of the third upper and lower premolars, obtained from a cave in the province of Sechuen (Szechuen), N.W. China, it appears from a comparison of the specimens in the British Museum, that pm. 3 is practically indistinguishable from the corresponding tooth of *H. felina* represented in figs. 2, 2a of plate XXXVA. of this volume, except in its slightly larger size. The lower tooth is also almost precisely similar to pm. 3 of the mandible of *H. felina* represented in figure 1 of plate XXXVIII. According to Prof. Owen's description the Chinese upper tooth differs from pm. 3 of *H. crocuta* by its slightly smaller size, its relatively lower crown, the greater convexity of its external vertical contour, and the larger size of its hind talon. Of the lower premolar it is observed by Prof. Owen that "the crown is broader both antero-posteriorly and transversely, but is lower vertically than in *H. crocuta*; it is consequently a stronger cone: its qualities for cracking and crushing bone are intensified. The ridge continued upward from the anterior basal talon is stronger than in *H. crocuta*; it is more completely an upward production of the talon itself; and this is less defined as an anterior tubercle than in *H. striata*."

It will be observed from these comparisons that the points in which the so-called *H. sinensis* differs from *H. crocuta* are precisely those in which *H. felina* differs from the same. Professor Owen also compares the Chinese teeth with those of the Siwalik hyænas in the British Museum, which he alludes to as *H. sivalensis*; though under that name were doubtless included both the teeth of *H. felina* and those of the next species. *H. sinensis* is said to be smaller than the Siwalik form; but its pm. 3 more nearly resembles the corresponding tooth of the latter than that of *H. crocuta*: the lower Chinese tooth is said to be more convex internally than the corresponding tooth of the Siwalik hyæna; but it is not more so than in the large Indian Museum mandible of *H. felina*. The third premolar of that specimen is absolutely larger than the corresponding tooth of *H. sinensis*, so that any specific distinctions on the ground of size may be disregarded. The resemblance of the Chinese teeth to those of *H. felina* is so close that in the writer's opinion it is highly probable that they are specifically the same: in which case Prof. Owen's name has the priority over that given by Mr. Bose. From the number of species of Siwalik hyænas, it may, however, be doubted whether the characters derived from single

¹ 'Quart. Journ. Geol. Soc.,' vol. XXVI., p. 422, pl. XXVIII., figs. 5-7. In the explanation of the plate the description of figures 5 and 6 should be reversed.

teeth are sufficient for specific determination; while even if *H. felina* and *H. sinensis* are really the same it seems doubtful if the former name ought to stand, as in that case it should never have been separated from *H. siwalensis* in the sense in which it was employed by Prof. Owen.

It appears, therefore, that the species of hyæna distinguished by Mr. Bose under the name of *H. felina* cannot be identified with any other species, with the possible exception of *H. sinensis*; and as it seems hazardous to identify the two, the former may receive a separate name. The name applied by Mr. Bose, as indicative of affinity with the cats, of which there is not the slightest trace (unless the occasional suppression of pm. 1, as in *H. eximia*, could be so interpreted¹) is a misleading and therefore objectionable one, but as the substitution of a fresh one would probably only entail confusion, it seems better to retain the name of *H. felina*.

It should be observed that the Chinese teeth are said to have been obtained in company with teeth of *Elephas* (*Stegodon orientalis*, Owen= ? *S. bombifrons*), *Tapirus*, *Chalicotherium*, and *Rhinoceros*, and are considered by Prof. Owen to be probably of upper pliocene, or pleistocene, age. The existence of Siwalik strata in China is probably indicated by the occurrence of *Elephas* (*S.*) *clifti* (*S. sinensis*, Owen) "in marly beds near Shanghai," and by the discovery of mammaliferous beds, and the lower molar of *Elephas* (*S.*) *insignis*, by Herr von Loëzy in the province of Kansu on the upper Hwangho river; while the occurrence of Siwalik and Narbada elephants in Japan indicates the extension of the same strata to that country. If the Chinese cave hyæna be the same as one of the Siwalik species, it would seem probable that the cavern deposits of Sechuen, lying between the Siwaliks of the Irawadi in Burma and those of Kansu, may also belong to the Siwalik epoch: the less complete degree of mineralization of the Sechuen fossils perhaps being accounted for by the different conditions under which they have been preserved.² It is, however, highly probable that both the Chinese and Japanese deposits contain representatives of the Narbadas, as well as of the Siwaliks.

The occurrence of a species of hyæna in the Siwaliks of India, showing considerable affinity to a species so prevalent in Europe in the pleistocene period, and now living in South Africa, and presenting no well-marked affinity to the other group of existing hyænas, one of which is now found in India and the adjacent countries, is a very remarkable fact; and one pointing to the conclusion that Asia, rather than Africa, should probably be regarded as the original home of the hyænas.

Distribution.—Remains of *H. felina* have been found throughout the sub-Himalayan Siwaliks, from the Ganges valley to the Punjab. The mandible from

¹ Even if this tooth were invariably absent, there would be no indication of feline affinity. The hyænas and the cats must probably be regarded as divergent branches of a common stock, in which the fullest dentition known in any member of these two groups must have been present. The suppression of a tooth in one of the hyænas can only, therefore, be regarded as a specialization in a line *parallel* to that of the cats. The presence of a tooth *above* the normal number in the latter group might be regarded as indicative of affinity with the hyænas, or rather with the common stock of the hyænas and the cats.

² See a paper by the writer on the Siwaliks of China and Japan in 'Rec. Geol. Surv. Ind.', vol. XVI., p. 158: the elephant tooth mentioned as not improbably belonging to *E. (S.) clifti* appears to be *E. (S.) insignis*.

the Jamu hills may possibly be of pleistocene age. Either this or a closely allied form also occurred in the pliocene, or pleistocene, of China; and it would be a matter of extreme interest to obtain remains of hyænas from the Siwaliks of Burma, as the country lying between India and China, since if the present species occurred there it would render it more probable that it might be specifically the same as the Chinese form.

Species 2: *HYÆNA COLVINI*, n. sp., *nobis*.

Syn. *Hyæna sivalensis*, Falc. and Caut., *in parte*.

History.—This species is mentioned here for the first time, the specimens on which it is founded having either been referred simply to the genus *Hyæna*, or to *H. sivalensis* of Falconer and Cautley.

Cranium.—In figure 2 of plate XXXV. of the present volume there is represented the skull of a Siwalik hyæna, formerly in the collection of the Asiatic Society of Bengal, and now in the Indian Museum (No. D. 47). In the catalogue of the former collection by Drs. Falconer and Walker¹ it bears the number S. 848; and is simply referred to the genus *Hyæna*, being described as "fragment of cranium a good deal crushed, and mutilated behind the orbits, showing all the teeth on the right side, except the small premolar; the teeth are considerably larger than those of the existing Indian *Hyæna*. On the left side canine seen in section." The specimen was presented by Col. Colvin, and is numbered 600 in the list of fossils given on page 184 of the Vth volume of the "Journal of the Asiatic Society of Bengal." In its present condition it shows on the right side the base of m. 1; pm. 4, with the summit of the middle lobe broken off, and showing a considerable degree of wear in the first and third lobes; the third premolar (pm. 3), also abraded at its summit; the base of pm. 2; the alveolus of the canine (c), filled with matrix; and the bases of the three incisors. On the opposite side there are the bases of the corresponding teeth as far back as pm. 2. No trace of pm. 1 is to be seen on either side, and pm. 2 is in proximity to the canine. In the figure the teeth of the left side have been restored. The worn condition of the cheek-teeth shows that the skull belonged to a fully adult animal. In the following table its dimensions are compared with those of the type skull of *H. felina*, and of recent skulls of *H. crocuta* and *H. striata*²:—

	<i>H. felina</i> .	Specimen.	<i>H. crocuta</i> .	<i>H. striata</i> .
Width of palate at pm. 4	4·3 (♂)	3·553	4·15	3·5
Interval between posterior border of palate and anterior border of incisive alveoli	4·7	4·52	4·9	4·74
Interval between molar alveoli and orbit	1·79			1·19
Space occupied by incisors	1·75	1·36	1·5 (1·49)	1·23 (1·27)
Interval between canines	1·55	1·18		1·2
" " hinder border of pm. 4 and canine	3·14	3·0	3·4	2·87
" " canine and pm. 2	0·24	0·21	0·55	0·42
" " m. 1 and middle line of palate	1·65	0·96	1·55	0·85
Length of pm. 2	0·67	0·61	0·6 (0·67)	0·68 (0·62)
" " 3	0·85	0·85	0·88 (0·94)	0·88 (0·8)
" " 4	1·37	1·5	1·48 (1·46)	1·2 (1·27)
Transverse diameter of m. 1	0·22 (♂)	0·59	0·2 (0·2)	0·58 (0·5)
Antero-posterior diameter of third incisor		0·49		0·41

¹ p. 189. See also "Palæontological Memoirs," vol. I., p. 343.

² The numbers in brackets indicate means.

³ Estimated by taking twice the width of the right side.

These dimensions show that while the length of the palate of the specimen under consideration is nearly the same as in *H. felina*, its width is considerably less; as is well shown by the interval between the canines and the space occupied by the incisors. In the following table the dimensions of pm. 4 are compared with those of the maxilla (*a*) and the Dublin (*b*) skull of *H. felina*, and also with the above-mentioned tooth of *H. crocuta* from the Forest-bed:—

	H. felina.		Specimen.	H. crocuta.
	a.	b.		
Total length	1.55	1.5	1.5	1.6
Width across tubercle	0.86		0.78	0.9
Length of first lobe		0.38	0.4	0.38
" second lobe		0.45	0.54	0.58
" third lobe	0.59	0.6	0.6	0.8

It is thus shown that this tooth is relatively larger than in *H. felina*, and has its middle lobe more developed; although considerably narrower across the tubercle. In respect of its larger middle lobe it is more like pm. 4 of *H. crocuta*, but is still distinguished by its smaller third lobe: its tubercle is considerably smaller than in that species. As in both *H. felina* and *H. crocuta*, the tubercle extends as far forwards as the blade. The length of this tooth exceeds the united length of the two preceding teeth; the reverse condition prevailing in *H. felina*. The true molar (m. 1) is of the elongated striatine type, and thereby differs markedly from the corresponding tooth of *H. felina*. Pm. 3 is a characteristic tooth, perfectly distinct from the corresponding tooth of the latter: it is set very obliquely to the line of the molar alveoli, and has only a minute hind talon, continued to the summit of the crown as a sharp ridge; while a similar ridge occupies the antero-internal side of the crown, the base of which probably represents an anterior talon, placed internally, instead of at the anterior border. Between these two ridges there was originally a distinct cingulum on the inner side, which unfortunately broke away before the specimen was figured. The vertical ridges and the cingulum enclose a flattish triangular space on the inner side, which may conveniently be termed the 'triangle.' This tooth is relatively shorter antero-posteriorly, and taller vertically than in *H. felina* and *H. sinensis*; while its hind talon is smaller, and its 'triangle' totally wanting in the other forms, which also lack the large inner cingulum. The external convexity is as well-marked in all. It is also smaller in proportion to pm. 4 than in *H. felina*, as may be seen by a comparison of the measurements; and is totally different from the corresponding tooth of *H. striata*; though somewhat more like that of *H. brunnea*, which, however, has larger talons, and a less distinct 'triangle,' with a more convex inner surface, and a lower crown. The corresponding tooth of *H. crocuta* has a similar tall crown, and a more or less distinct 'triangle,' though the distinctness of this varies considerably in different individuals,¹ and is never quite so well-marked as in the Siwalik fossil. The hind talon of pm. 3 is moreover considerably smaller in the fossil than in *H. crocuta*; but in general contour the teeth of the two forms have a very

¹ In two fine recent skulls in the Royal College of Surgeons (Nos. 523, 524) the 'triangle' is much more distinctly marked in the former (a specimen collected by Gordon Cumming) than in the latter.

marked resemblance, though they are broadly distinguished by the one being set obliquely and the other parallel to the molar alveoli; as well as by the squared hinder end of this tooth in *H. crocuta*. The profile of this skull is very similar to that of *H. felina*.

Second specimen.—In figures 1 of plates XXXV., XXXVI., there are given two views of another cranium of a Siwalik hyæna, also formerly in the collection of the Asiatic Society of Bengal, and now in the Indian Museum: it was presented by Col. Colvin and bears the number S. 847 in Drs. Falconer and Walker's catalogue of the Society's collection, where it is alluded to¹ as "cranium, nearly entire, deficient only in the right zygomatic arch, and in the basal part of occiput, but covered with matrix, and the teeth so mutilated that only the second premolar is distinctly seen; the incisors and canines *in situ*, but broken off." It has now been cleaned from matrix, and exhibits² the six incisors (i) with their summits broken off; the bases of the canines (c), which are not fully protruded, and, therefore, indicate that the skull belonged to an adolescent animal; the complete pm. 2 of the left side, which by its proximity to the canine, indicates the absence of pm. 1; the base of the right pm. 3; the alveoli of the carnassials (pm. 4), filled with matrix; and the complete m. 1 of either side. In the following table the dimensions of this specimen are compared with those of the last:—

	First specimen.	Second specimen.
Width of palate at pm. 4	3.55	3.54
Interval between posterior border of palatines and anterior border of incisive alveoli	4.52	4.55
" " post-orbital process of frontal and same	4.35	4.75
" " hinder border of carnassial and hinder border of canine	3.0	2.9
Space occupied by incisors	1.36	1.46
Length of pm. 2	0.61	0.67
" " 3	0.85	0.85
" " 4	1.5	1.45 (?)
Transverse diameter of m. 1	0.59	0.48 0.45
Antero-posterior diameter of third incisor	0.49	0.52
Interval between m. 1 and middle line of palate	0.96	0.99

These measurements show that the skull under consideration agrees with the first specimen in the width and length of the palate, in the spaces occupied by the cheek-teeth and the incisors, and, approximately, in the size of the former: it also agrees in the width between the true molars and the median line of the palate, and in the absence of pm. 1; as well as in the oblique position of pm. 2 and pm. 3. It differs, however, slightly from the first specimen by the greater length of the interval between the post-orbital process of the frontal and the incisive border, but this cannot be considered more than an individual variation. The most important difference between the two skulls is the smaller size of m. 1 in the second specimen;—a difference so great that it was originally considered as indicating a complete transition from *H. felina* to *H. sivalensis* of Mr. Bose; the great differences between

² See "Palæontological Memoirs," vol. I., p. 343.

³ In the palatal view, owing to the imperfection of the occiput, the specimen is only drawn as far back as the post-genoid process.

the other teeth of those forms and of the present skulls not being then known. With regard to the difference in the size of m. 1 in the two specimens, it will be noticed that the transverse diameter of this tooth on the left side of the second specimen is 0.48, while in the first it is 0.59; giving a difference of 0.11. The extremes in the size of the corresponding tooth in *H. striata*¹ are 0.49 and 0.58, or a difference of 0.09; indicating that the difference in the two specimens under consideration need not indicate more than individual variation. The true molar of the second specimen is readily distinguished from the corresponding tooth of the type of *H. felina* (in which alone this tooth is visible), by being provided with three distinct roots (in place of one or two), as in *H. striata*; the largest of which is placed on the inner side, and is totally wanting in *H. erocuta* and *H. felina*. Again, the true molar of the skull under consideration is placed with its inner border at the same distance from the median line of the palate, as in the first specimen, and is not squeezed close up to the carnassial as in *H. felina*. The carnassial of the second specimen may have been slightly smaller than that of the first specimen. The second premolar (compare pl. XXXV., fig. 1, with pl. XXXVA., fig. 2) differs from the corresponding tooth of *H. felina* by its more oblique position, its shorter and broader crown, and by the presence of a well-marked cingulum on the inner side of the posterior extremity. It closely resembles the corresponding tooth of *H. erocuta*, but is more obliquely placed. The incisors both in this and the first skull are smaller than those of *H. felina*; the third of the series being distinguished from the detached specimen referred to that species by the presence of a conspicuous inner cingulum. The profile of the skull under consideration has not attained its adult form.

Maxilla.—In figures 1, 1a, and 3, 3a, of plate XXXVA. there are represented two specimens of detached left maxillæ of Siwalik hyænas,² in the British Museum, the teeth of which agree so nearly with those of the first skull described above as probably to be within the limits of individual variation. The former specimen (No. 37,139) shows pm. 3 and pm. 4; m. 1 having probably been broken away: the carnassial in this specimen is unusually long, and exhibits the crocutine characters of a long third lobe, and the forward position of the tubercle: the third lobe is as long as in an equal-sized tooth of *H. erocuta*, but the middle lobe is smaller, and the width across the tubercle less. The ridges of pm. 3 are more approximated than in the type skull, but this character appears somewhat exaggerated in the figure, owing to the more outward inclination of the tooth, probably due to crush: the inner cingulum is well displayed.³ In the second specimen (No. 37,140) m. 1 is present, and is a transversely elongated tooth, as in the type skull. The third lobe of pm. 4 is relatively smaller than in *H. erocuta*; and its tubercle is placed well forward; the

¹ Taken from Mr. Busk's tables and the specimen of which the dimensions are given above.

² These figures have been copied (but reversed) from supplemental plate L., figs. 7, 7a, and 8, 8a, of the "Fauna Antiqua Sivalensis."

³ The want of this cingulum through fracture in the type skull also tends to make the vertical ridges appear abnormally far apart.

extremity of the blade is, however, somewhat in advance, but the hinder end of pm. 3 is enclosed in the angle between the blade and tubercle, as in *H. crocuta*, and is not entirely in advance as in *H. striata*. The third premolar has the large inner cingulum, the high crown, and the small hind talon, characteristic of the present form; but the vertical ridges are placed farther apart than in the last specimen, being more like those of the type skull. The true molar in this specimen in respect of size is intermediate between the same tooth in the two skulls described above, and is placed close to the carnassial. The specimen may be provisionally referred to the same species as the skulls.¹ The dimensions of the two specimens described above are as follows, *viz.* :—

	No. 37,139.	No. 37,140.
Length of <u>pm. 3</u>	0·85	0·85
Height „ „ „	0·88	
Interval between vertical ridges of ditto	0·58	0·65
Length of <u>pm. 4</u>	1·65	1·5
Height of hind lobe of ditto	0·68	

In figure 4 of plate XXXV. there is represented the left maxilla of a Siwalik hyæna, collected by Mr. Theobald in the Punjab: it shows pm 3, and pm 4 (the latter somewhat damaged), and m. 1. The first of these teeth² is almost identical with the corresponding tooth of the specimen represented in plate XXXVA., fig. 1: the carnassial is, however, as short as in the skull represented in plate XXXV., fig. 1, with its second and third lobes relatively small: its tubercle being broken makes its blade appear to extend considerably in advance of that former part, although it really does so about as much as in the specimen represented in plate XXXVA., fig. 3: the tubercle seems partly aborted. The true molar is of the same length as in the skull represented in plate XXXV., fig. 1, but is considerably narrower antero-posteriorly; and approximated to pm. 4: it is inserted by three roots and in position is like the corresponding tooth of the specimen represented in plate XXXVA., fig. 3. It is probable that the antero-posterior shortening of m. 1 in this specimen must only be regarded as another variation: its transverse diameter is 0·45, and the antero-posterior 0·19.

In the Dublin Museum there is among the Siwalik fossils purchased from Dr. Beattie (No. 41) part of the left maxilla of a hyæna, with the last three cheek-teeth. From the teeth of this specimen being precisely similar to those of the skull represented in plate XXXV., fig. 2, and from the shape of the fragment, it is believed that it is the missing part of that skull, which has been restored in the figure.

In plate XXXV., fig. 5, there is given the outer view of a left upper carnassial of a Siwalik hyæna, collected by Mr. Theobald in the Kangra district, now in the Indian Museum. The specimen belonged to a fragment of the maxilla of a young

¹ Pm. 3 appears set somewhat less obliquely than in the type skull, but this is mainly, if not entirely, due to the slightly different position of the specimens.

² This tooth in the specimen is viewed more from the outer side than in any of the other specimens; the crushing to which the specimens have been subjected have thrown the teeth out of their proper inclination, so that it is impossible to figure them all in the same position.

individual, in which the milk-teeth were present, but had lost their crowns: the figured tooth was 'developed' by chiselling away the wall of the jaw. Internally to pm. 4 there is the base of a transversely elongated m 1; and as the former tooth shows the high crown and large middle and hind lobes characteristic of the specimens described above, it is probable that the specimen should be referred to the same species as the latter. It is also probable that a right upper carnassial of a Siwalik hyæna in the British Museum (No. 15,413), represented in figures 9, 9a of plate L. of the supplemental plates of the "F.A.S.," belongs to the same species.

Mandible.—In figure 3 of plate XXXVIII., and in figure 4 of plate XXXIX. of this volume, there are given two views of the hinder part of the left ramus of the mandible of a Siwalik hyæna, formerly in the collection of the Asiatic Society of Bengal, to which it was presented by Col. Colvin, and now in the Indian Museum (No. D. 51). The specimen is numbered 602 in the list of Siwalik fossils given by Messrs. Baker and Durand,¹ and is entered as *Hyæna*. In Dr. Falconer and Walker's Catalogue of the Vertebrate Fossils of the Society² it bears the number S. 851, and is described as "Feline,—Fragment of horizontal ramus, lower jaw, right [*sic*] side, containing the two last molars *in situ*: would be about the size of *Felis cristata*, F. and C." The specimen, as mentioned by Dr. Falconer, shows pm. 4 and m. 1; the summit of the main lobe of the former having been broken off, but the latter perfect and somewhat worn; the condition of the teeth indicates that the specimen belonged to an adult animal. The mandible below the two teeth is quite perfect. The form of the teeth, and especially the conspicuous talon of m. 1, leaves no doubt that the specimen belongs to a species of *Hyæna*. The carnassial is a large tooth, with a relatively small talon, and no vestige of a cusp on the inner side, but with a cingulum on part of the outer surface of the anterior lobe: it is essentially crocutine in form, and very like the corresponding tooth of *H. felina*, but distinguished by the slightly larger talon, and the external cingulum. Pm. 4 has a small anterior, and a large posterior talon: comparing it with the corresponding tooth of the large jaw of the latter species represented in figures 1 of plates XXXVIII., XXXIX., it will be found that this tooth differs by its proportionately smaller size, smaller anterior talon, and in that its anterior vertical ridge, instead of being on the same line as the hinder ridge, is placed considerably to the inner side. It will be shown below that the jaw is relatively less deep than in *H. felina*.

In the Dublin Museum there is among the Siwalik fossils (No. 39) the nearly complete left ramus of a hyæna, showing the whole dentition in an early stage of wear; pm. 4 alone being somewhat broken. In that specimen m. 1 and pm. 4 are precisely similar to the corresponding teeth of the last specimen; pm. 3 has no anterior talon. The crowns of pm. 3 and pm. 4 are relatively higher than in *H. felina*, and characterized by the convexity of their external vertical contour. The interval between the canine and pm. 2 is remarkably small; pm. 1 being absent, as in all the existing species. The jaw is relatively slender.

¹ 'Journ. As. Soc. Beng.', vol. V., p. 184.

² Page 189; see also "Palæontological Memoirs," vol. I., p. 343.

The accompanying woodcut (fig. 14) shows two views of another *hyaena*'s

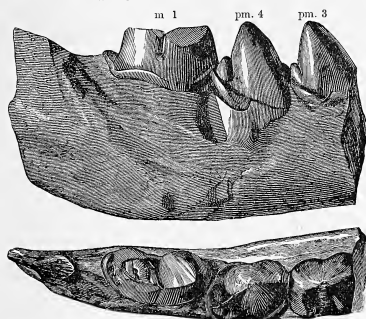


Fig. 14. *Hyæna colvini*, nobis. Part of right ramus of a mandible, from the Siwaliks; in the British Museum (No. 16,578). From the external and superior aspects. $\frac{1}{2}$.

(No. 16,526), exhibits the canine and the last three premolars, and is figured in supplemental plate L, figure 9, of the "F.A.S."

In the following table the dimensions of the four specimens mentioned above are compared with those of the five mandibles referred to *H. felina*.

	Present species.				<i>Hyæna felina</i> .			
	Ind. Mus. D. 51	Dublin specimen.	Brit. Mus. 16,526	Brit. Mus. 16,578	Brit. Mus. 39,731	Ind. Mus. D. 50	Brit. Mus. 16,566	Dublin skull.
Length of series of cheek-teeth		3.1			3.1	3.18		3.18
" " pm. 2			0.6	0.58		0.59	0.62	0.65
" " " 3			0.78	0.76		0.75		0.85
" " " 4		0.85	0.91	0.84	0.76		0.82	0.85
" " m. 1		1.15	1.12		1.05	1.04	1.01	1.0
Depth at " " " "		1.25	1.36	1.3	1.32	1.56	1.73	1.73
Interval between canine and pm. 2			0.2	0.18		0.39		0.4

It will be seen from these dimensions that in the specimens under consideration $\overline{m.1}$ is longer in proportion to $\overline{pm.4}$, than in *H. felina*; the differences in three specimens of the former being respectively 0.30, 0.29, and 0.21; and in four of the latter 0.19, 0.15, 0.13, and 0.12; giving means of 2.66, and 1.47. Similarly in the former the jaw is relatively less deep than in the latter; the respective means being 1.3 and 1.72. The diastema is also smaller in the specimens under consideration. These mean differences, coupled with the differences in the form of the earlier premolars, and the presence of the cingulum to $\overline{m.1}$ in the specimens under consideration, leave little doubt that the latter are specifically distinct from the

¹ Also figured in supplemental plate L, figs. 8, 8a, of the "F.A.S."

mandibles referred to *H. felina*. The crocotine type of the carnassial renders it pretty certain that the former mandibles should be referred to a species in which the upper carnassial was also of the crocotine type: in this respect, therefore, they might well belong to the same species as the skulls and upper jaws described above. The more slender form of the mandibles, the smaller size of the diastema, the relatively larger $\overline{m.1}$, and above all the internal position of the anterior vertical ridge of $\overline{pm.4}$, and the relatively taller crowns of this and the preceding tooth, are, moreover, all characters in which the lower jaws of the skulls described above would be expected to differ from those of *H. felina*; and there is, accordingly, every probability that the mandibles under consideration belong to the same species as the skulls and upper jaws.

Comparisons.—Assuming all these remains to be rightly associated, the species to which they belong will be characterized by having its skull and mandible somewhat more slender than those of *H. felina*; by having carnassials more nearly of the crocotine type; by the upper true molar being tricuspidate, and transversely elongated, though varying considerably in size; by (as far as is known) the absence of $\overline{pm.1}$, and the smaller length of the diastema in both jaws; by the tall curved crowns of the conical premolars, the inward position of the anterior vertical ridge in $\overline{pm.3}$ and $\overline{pm.4}$, and the small size of the anterior talon of the latter. The species agrees with typical hyænas in the absence of $\overline{pm.1}$ and $\overline{m.2}$.

The distinctions between the specimens thus grouped together from the corresponding parts of *H. felina* have been already sufficiently indicated in the course of the foregoing descriptions, and are of such importance as apparently to preclude the possibility of uniting the two forms under one species. The points distinguishing the specimens under consideration from *H. felina*, will have the same value in the case of *H. sinensis*.

In regard to its dentition generally, the present species makes in many respects a very strong approach to *H. crocuta*, especially in the characters of the premolars and carnassials: it is, however, distinguished by the tricuspidate character and generally larger size of $\overline{m.1}$; the absence (as far as is known) of $\overline{pm.1}$; the smaller size of the diastema; the larger talon and more distinct outer cingulum of $\overline{m.1}$; and the generally more pronounced character of the inner vertical ridges and 'triangle' of $\overline{pm.3}$, and the oblique setting of this and the preceding tooth. The third lobe of $\overline{pm.4}$ is generally smaller, and the width across the tubercle less, but in one instance the third lobe is as long as in *H. crocuta*. The hind talons of $\overline{pm.3}$ and $\overline{pm.4}$ are, moreover, relatively smaller; while the ridge on the inner side of the hind talon of the latter tooth is less developed, and does not extend internally to the main lobe. The skulls of the two also differ considerably, the Siwalik specimens being smaller and more slender. The mandible of the latter is also more slender and straighter inferiorly, lacking the great increase in depth below $\overline{m.1}$, which forms such a marked feature in *H. crocuta*.

H. antiqua is too imperfectly known to admit of accurate comparisons. Of the

species mentioned in the list on pp. 276-7 not already alluded to, *H. perrieri*, if distinct from *H. crocuta*, seems to approach the present species by the rather larger size of $\overline{m.1}$ and the larger talon of $\overline{m.1}$: it is, however, probable that in other points it is distinguished by the same characters as *H. crocuta*. *H. eximia* is sufficiently distinguished by the presence of $\overline{pm.1}$ and the small size of the inner tubercle of $\overline{pm.4}$: and it is probable that in *H. brevirostris* similar differences prevail: the premolars of these species are of quite a distinct type from those of the present species. In *H. græca* both $\overline{pm.1}$ and $\overline{m.2}$ are present, and the talon of $\overline{m.1}$ is relatively large. In all the other species the carnassials are of quite a distinct type to those of the specimens under consideration. As it will be shown below that these specimens are totally distinct from *H. sivalensis* of Mr. Bose, and as they cannot be identified with any other sufficiently described species, it appears that they belong to a new species, for which the name *H. colvini* is proposed, in honour of Col. Colvin, the discoverer of the two skulls described above, and numerous other Siwalik fossils.

This species appears entirely to do away with the generic distinctness of *Crocuta*, since while its premolars and lower carnassial are of the type of the spotted hyæna, (although $\overline{pm.4}$ indicates a tendency to a transition from the crocutine to the striatine type), its upper true molar, in its different variations, forms an almost complete transition from that of the striped to that of the spotted species, though generally of the type of the former. Although *H. colvini* is in these respects intermediate between *H. felina* and *H. crocuta* on the one hand, and *H. striata* and *H. brunnea* on the other, yet if the absence of $\overline{pm.1}$ be constant (and it is in any case very frequent) the former species must be regarded as a highly specialized member of the genus, and cannot have been the direct ancestor of any of the living forms. The combined evidence of this species, of *H. crocuta*, and *H. felina* seems to indicate that in those species which attained a high degree of specialization in the structure of their carnassial teeth—i.e., an approach in the structure of those teeth to the homologous teeth of the modern cats—the concomitant reduction in the other teeth which usually occurs in such cases, took place either in the diminution of $\overline{m.1}$, or in the suppression of $\overline{pm.1}$, or in a combination of both these characters.

Distribution.—The present species ranged from the region of the typical Siwalik Hills to the Punjab.

Species 3: HYÆNA MACROSTOMA, n. sp. nobis.

History.—The name of this species is mentioned here for the first time.

Cranium.—In plate XXXVII. there are given two views of the cranium of a Siwalik hyæna collected by Mr. Theobald at Jabi, Punjab; while a reduced profile view of the same specimen is given in fig. 2 of the preceding plate. The specimen comprehends the whole of the skull, and is in excellent preservation. It has, however, lost both zygomatic arches, the occipital condyles, and a part of the sagittal crest. The incisors and canines have fallen out from their sockets, and the

crowns of all the cheek-teeth have been hammered off, with the exception of the right carnassial. The partially worn condition of the latter tooth, and the large size of the alveoli of the canines, shows that the skull belonged to an adult individual.

In order to show the distinctness of this skull from either of the preceding species it will perhaps be simplest to commence by giving its dimensions, which are compared below with those of *H. striata*, viz.:—

	Specimen	<i>H. striata</i> .
Width of palate at pm. 4	3·7	3·5
" " " " 3	2·8	3·22
" " " behind canine	1·83	2·0
" " " at "	2·12	2·14
Interval between posterior border of palate and anterior border of incisive alveoli	5·32	4·74
" " inferior border of foramen magnum and the same	9·28	8·4
Width across postorbital processes of frontals	2·79	3·07
" below " " " "	2·39	2·06
Interval between postorbital processes of frontal and anterior incisive border	5·75	4·9
Space occupied by incisors	1·08	1·23
Interval between canines	1·18	1·2
" " hinder border of pm. 4 and canine	3·16	2·87
" " canine and pm. 2	0·6	0·42
Length of pm. 1	0·3	0·29
" " 2 (alveolus)	0·63	0·55
Width " " " "	0·35	0·38
Length " " 3 "	0·9	0·76
Width " " " "	0·46	0·48
Length " " 4	1·31	1·2
Transverse diameter of m. 1	0·62	0·58
Antero-posterior " " " "	0·3	0·26
" " " " canine	0·68	0·68
" " " " third incisor	0·38	0·41

A comparison of these dimensions with those of *H. felina* and *H. colvini* given above¹, as well as of the figures of the specimen under consideration with those of the former, will leave no doubt that the latter is specifically distinct from both: the most marked distinction being in the form of the palate, which is relatively longer and narrower. Other important points of distinction will be incidentally alluded to, but the differences are so great that it will be unnecessary to institute a rigorous comparison between the three types of skull.

Regarding the dentition of the specimen, it will be seen from the figures that the incisors occupy a much smaller space than in either of the preceding species: the smallness of this space being mainly caused by the reduced size of the third incisor. In these respects the specimen differs from all other species of the genus. The canines are relatively large, and their alveoli project unusually outwards. Pm. 1 is present, and separated by a considerable interval both from the canine and pm. 2; the specimen in this respect being apparently quite peculiar. The alveoli of the remaining cheek-teeth form a nearly straight line; the marked outward bulge which occurs in most species at the junction of pm. 3 and pm. 4 being absent; although *H. eximia* comes nearest in this respect. Although the crowns of pm. 2 and

¹ pp. 822, 290.

pm. 3 are wanting, the shape of their alveoli shows that these teeth were remarkably long and narrow; no other species of the genus of which the skull is known having teeth of similar proportions. Pm. 4 is preserved in a somewhat damaged condition on the right side, and is relatively short; with the proportions of the corresponding tooth of *H. striata*; the hind lobe not being relatively as large as in *H. colvini* and *H. erocuta*. M. 1 is unusually large; agreeing almost exactly in size with the corresponding tooth of *H. (Hyenictis) græca*.¹ On the right side this tooth is situated almost entirely behind pm. 4 :—a peculiarity known only in this and the next species. On the opposite side the homologous tooth is also placed unusually far back.

In respect of all the dental characters indicated above (*viz.*, the elongated premolars, the long interval between the canine and pm. 2, and the large size and backward position of m. 1) the skull under consideration makes a marked step from typical hyænas in the direction of *Canis* and the *Viverride*. The long narrow palate is also another character indicating affinity in the same direction.

The form of the posterior free border of the palate (*pal.*) is different from that of any other species of hyæna of which the skull is known; in all of which this part forms a regular U-shaped notch. In the present specimen, however, the centre of this part forms a straight line, at either extremity of which the lateral borders of the posterior nares (partly broken in the specimen) commence nearly at right angles, and continue with a marked inward inclination towards the pterygoids. In this respect the specimen agrees exactly with *Canis*;² and if a skull of that genus had m. 2 removed, and m. 1 reduced in size, and placed internally to pm. 4, it would be almost impossible to distinguish its palate from that of the present specimen. In *Ictitherium*³ the form of this part is as in *Hyæna*: in *Viverra* it is also very similar, the lateral borders of the nares running, however, antero-posteriorly in place of inclining inwards. In *Cynodictis*⁴ the free border of the palatines and the form of the posterior nares appears to be very similar to that obtaining in *Canis* and the fossil under consideration.

The other parts of the base of the fossil skull do not present any very striking features: but, as in other hyænas, there is no postglenoid foramen. On its superior aspect the skull is distinguished from all other hyænas by the small development of the sagittal crest (see plate XXXVI., fig. 2); in this respect nearly resembling the skull of an immature individual of a typical hyæna (*ibid.*, fig. 1).⁵ The profile of the sagittal crest is markedly convex;—more so than in any allied genus. The orbit is relatively large (the vertical diameter in the fossil and *H. striata* being respectively 1·5, and 1·33 inches); and the postorbital processes of the frontal are small. The anterior nasal aperture is oval and relatively large; and the nasals are unusually long, their respective inner diameters in the fossil and *H. striata* being

¹ Gaudry, "Animaux Fossiles et Géologie de l'Attique," pl. XV., fig. 6.

² The median prominence for muscular attachment may be disregarded: it has probably been broken away in the fossil.

³ Gaudry, *op. cit.*, pl. VII.

⁴ Filhol, "Phosphorites du Quercy," figs. 60, 63.

⁵ Fig. 1 has the occipital region more elevated than it is in fig. 2.

2.43 and 1.92 inches. The premaxillæ, as in existing hyænas, do not reach the frontals, but are separated by a space of $\frac{1}{2}$ inch. Apparently a similar condition prevails in *Ictitherium*,¹ *Cynodictis*,² and *Canis*. The proper occipital surface is essentially hyænine.

Mandible.—In figure 4 of plate XXXVIII., and in figure 6 of plate XXXIX., there are given two views of the anterior part of the left ramus of a mandible of a hyænoid animal, collected by Mr. Theobald in the Siwaliks of Jabi, which there is every reason to believe belongs to the same species as the skull described above. The specimen shows anteriorly the broken bases of two incisors (i); the bases of the canine (c), of $\overline{\text{pm. 1}}$, and $\overline{\text{pm. 2}}$; the nearly complete $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$, and the alveoli of $\overline{\text{m. 1}}$; behind which it is broken off. Part of the summit of $\overline{\text{pm. 4}}$ has been carried away, but this and the preceding tooth are otherwise nearly perfect; and being considerably worn indicate that the jaw belonged to a fully adult animal. The two remaining premolars are constructed on the type of those of *Hyæna*; but, as will be seen from the measurements given below, are considerably longer and narrower than those of any existing species of the genus. The first of these teeth ($\overline{\text{pm. 3}}$) has a minute anterior, and a large posterior talon; while in $\overline{\text{pm. 4}}$ both talons are large: and in the latter tooth there is a well-marked cingulum on the inner side of the hind talon, running forwards and inwards, as in *H. striata*. In addition to the elongated form of the two last premolars, the presence of $\overline{\text{pm. 1}}$ and the long interval between the canine and $\overline{\text{pm. 2}}$ distinguishes this specimen from the mandibles of both the preceding Siwalik species, and also from those of all the existing species. In the same characters the specimen agrees with the skull described above; while in addition to this there is the circumstance, as will be seen from the measurements given below, that in the former the symphysis is unusually narrow (indicating a narrow palate), and the third incisor remarkably small. Since it will be shown below that this form of jaw is different from that of *H. sivalensis*, it may be taken as pretty certain that the present specimen belongs to the same species as the skull described above.

The only non-Indian species of hyæna in which $\overline{\text{pm. 1}}$ is normally present are *H. eximia*, *H. brevirostris* (?), *H. græca*, and *H. chevetis*. In the two former³ the premolars are of the normal hyænine type, and such appears also to have been the case with the third⁴; in the fourth,⁵ however, the premolars have very nearly the same proportions as those of the present specimen, as will be seen in the subjoined table of measurements, in which the dimensions of the latter are compared with those of *H. chevetis*⁶ and *H. striata*,⁷ viz.:

¹ Gaudry, *op. cit.*, pl. VII., fig. 3.

³ Gaudry, *op. cit.*, pl. XIII.

² Filhol, *op. cit.*, fig. 58.

⁴ and ⁵ *Ibid.*, pl. XV.

⁶ These are mainly converted from the measurements given by M. Gaudry, but two are taken from his figure.

⁷ These dimensions are means, and rather smaller than those of the skull given above.

	Specimen.	<i>H. charettis</i> .	<i>H. striata</i> .
Length of pm 1	(?) 0·17	0·25	
" " " 2	(?) 0·56	0·64	0·52
" " " 3	0·8	0·79	0·72
Width " " "	0·43		0·5
Length " " 4	0·98	0·87	0·78
Width " " "	0·48	0·45	0·48
Length " m. 1	(?) 0·9	0·94	0·81
Depth " jaw at m. 1	1·6	1·44	1·39
Greatest width of ramus at symphysis	0·68		0·85
Interval between canine and pm. 2	0·68	0·51	0·45
" " " " m. 1	3·0	2·79	2·47
Antero-posterior diameter of canine	0·65	0·64	0·68
" " " " third incisor	0·27		0·32
Transverse " " " "	0·17		0·22

It will be seen from these dimensions that in the Siwalik jaw there is a greater difference in the respective lengths of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ than in *H. charettis*: the respective intervals between the canine and $\overline{\text{pm. 2}}$, and $\overline{\text{m. 1}}$, are moreover considerably smaller in the latter; and it is not improbable that $\overline{\text{m. 1}}$ was larger in the same. These differences are such as to render it improbable that the Siwalik jaw belongs to the European species; although there can be no doubt that it belonged to a closely allied form. It is unknown whether $\overline{\text{m. 2}}$ was present in either. The carnassial of the European form had a large talon and a distinct inner cusp to the blade; whence it may be inferred that such appendages probably existed in the homologous tooth of its Siwalik ally. In the latter the middle incisor was thrust above the other two, as in existing species. The mandible bears two nervous foramina on the outer side; whereas there is but one such foramen in *H. charettis*.

It may be remarked that in addition to the more slender form of the premolars, as compared with those of *H. striata*, the talons of $\overline{\text{pm. 4}}$ are considerably more developed than in that form. In the fossil $\overline{\text{pm. 3}}$ is narrower than $\overline{\text{pm. 4}}$; the opposite condition prevailing in the recent species.

Distinctness and affinities.—It now remains to consider the affinities of the species to which the above-described cranium and mandible belong. In the first place it will be apparent that the only described species with which they have any affinity is *H. charettis*; and since the mandible differs somewhat from that of the latter, it is probable that the Siwalik form should be referred to a distinct species, for which, from its most striking character, the specific name *macrostoma* is proposed.

With regard to the generic title, Prof. Gaudry in his description of *H. charettis*¹ remarks: "*La carnassière inférieure de l'Hyæna charettis est très voisine de celle de l'hyène rayée et de l'Hyæna arvernensis; sa carnassière supérieure a aussi un aspect un peu hyénoïde. C'est pourquoi, en attendant qu'on ait trouvé des pièces plus complètes, nous laissons ce fossile auprès des hyènes. Nous voulons éviter de créer un nom de genre pour un animal imparfaitement connu; mais ses prémolaires si longues, étroites et écartées, semblent annoncer qu'il devra former un type nouveau. Nous ne savons point s'il avait une seule ou plusieurs tuberculeuses; les prémolaires sont assez différentes de celles des hyènes pour faire supposer*"

¹ *Op. cit.*, vol. I., p. 94.

des formes particulières dans la partie tuberculeuse de la dentition. Les dents que nous connaissons paraissent avoir été moins favorablement disposées que celles des autres hyènes pour broyer des corps durs."

The present specimens have shown that the upper dentition is numerically the same as that of normal hyænas; while even if $\overline{m.2}$ were present, it will be shown below that no good reason will be afforded for generic distinctness. It only remains, therefore, to consider whether the form of the premolars, the large size of $\overline{m.1}$, the narrow elongated palate, the form of the posterior nares, the relations of the premaxillæ to the frontals, and the small sagittal crest, afford grounds for generically separating the present species, and *H. cheretis*, from *Hyæna*. The other characters of the Siwalik skull and jaw agreeing, however, so essentially with those of normal hyænas, and the next species forming a transition between the two in respect of certain dental characters, it appears to the writer that it would be inadvisable to generically separate the present highly abnormal form from other hyænas.

Classing, then, *Hyæna macrostoma* in the same genus with existing hyænas, that species must be regarded as constituting an important link between the more typical members of the genus, and the viverroid and canoid Carnivora. It is not a little remarkable that in some respects it appears to have more affinity with the generalized genus *Cynodictis* than with *Ictitherium*, which is otherwise more closely allied to the hyænas. It is of course impossible to say whether *H. macrostoma* resembled the existing hyænas in its general external form: but it may be affirmed that its skull had a longer facial portion than in any existing species, from which it may be inferred that the head had a more wolf-like appearance than in existing hyænas. The more elongated and slender jaws, coupled with the slighter form of the premolars, also renders it probable, as was suggested in the case of *H. cheretis* by Prof. Gaudry, that *H. macrostoma* did not obtain the chief part of its nutriment by cracking the bones of the larger Herbivora, which had resisted the teeth of other Carnivora, as is the case with the living hyænas; but that on the contrary its habits were more like those of the wolves of the present day.

Distribution.—The cranium and mandible described above are the only known remains of the species, and were both obtained from the Punjab.

Species 4: *HYÆNA SIVALENSIS*, Bose.

History.—In his memoir on the Carnivora of the Siwaliks¹ Mr. Bose, under the name of "*H. sivalensis*, Falc., et Caut. (?) et nob.," describes one of the skulls of hyænas in the British Museum (No. 37,133), and distinguishes it from his *H. felina*. Under the former name, however, Mr. Bose ranks several other specimens in the same collection, consisting of fragments of the maxilla and mandible²; all of which, with one possible exception, belong to other species.² The whole of these specimens

¹ Quart. Journ. Geol. Soc., vol. XXXVI., p. 128.

² These specimens are B.M., No. 16,583 ('F.A.S.,' pl. I, fig. 2); No. 37,137 (this work, pl. XXXVA., fig. 4: sp. non det.); No. 37,138 (*ibid.*, fig. 2—*H. felina*); No. 37,139 (*ibid.*, fig. 1—*H. celeini*); No. 16,578 (woodcut, fig. 14, p. 296—*H. celeini*); No. 39,731 ('F.A.S.,' pl. I, fig. 5—*H. felina* (?)); No. 37,141 (*ibid.*, fig. 7—*H. felina* (?)).

are described together, and the not unnatural conclusion arrived at that "no other species of Hyena is known in which there is such a remarkable combination of characters shared by such divergent forms!" The one specimen of a mandible in the British Museum collection (No. 16,555) which alone can belong to the same species as the type skull, is ignored by Mr. Bose; and this is also the case with two incomplete skulls (Nos. 37,134 and 37,136): while not the slightest reasons are given for these omissions, or for the association of the specimens mentioned above under *H. sivalensis*.

The name *H. sivalensis*, Bose, will be adopted here for the species to which the typical cranium belongs; but it will be utterly useless to quote any part of Mr. Bose's description, as that includes the other specimens mentioned above.

Type cranium.—Two full-sized views of the above-mentioned cranium are given in plate XXXIV. of the present volume: it is also figured in the "F.A.S." and the "Palæontological Memoirs";² where the profile and occipital views are given, on a small scale. It seems from the latter figures that, with the exception of the loss of the summit of the occipital crest, and both zygomatic arches, the specimen was originally fairly perfect as far forwards as the canines, where it is broken by a fracture extending obliquely from the anterior border of the right canine to the posterior border of that of the opposite side. In its present condition both occipital condyles are wanting. The right canine has lost its enamel, and its summit. On the same side there remain pm. 2, pm. 3, and pm. 4; all considerably worn, and thus indicating the full age of the specimen. On both sides the alveoli of pm. 1, filled with matrix, are visible: the interval between the canine and pm. 2 is comparatively short.

Commencing with pm. 4, it will be seen from the figures that the hind lobe of this tooth is not longer than the middle lobe; the whole tooth being relatively small, and its inner tubercle well developed, although not extending so far forwards as the blade. In these two points this tooth differs from the corresponding tooth of *H. felina*, *H. colvini*,³ and *H. crocuta*, and agrees with that of *H. striata* and *H. brunnea*; and these differences are of such importance as to indicate that the specimen has no affinity with either of the first three species mentioned above, but that its relations are entirely with *H. striata* and its allies; whence comparisons will accordingly be confined to the latter. The true molar (m. 1) is an elongated tooth, with its transverse diameter of about the same size as in the corresponding tooth of *H. striata*, but with the antero-posterior diameter considerably larger. As the palate of the present specimen is narrower than in *H. striata*, the whole dimensions of m. 1 are proportionately larger than in that species. The true molar is placed to a great extent behind pm. 4; instead of entirely on its inner side as in *H. striata*. The crowns of

¹ Supplemental plate K, figs. 2, 2a, 2b, 2c.

² Vol. I., pl. XXXV., figs. 1-4. Both this and the plate in the "F.A.S." are erroneously lettered *Felis cristata*.

³ Two specimens represented in plate XXXV., fig. 4, and XXXVA., fig. 3, are apparently an exception; but in the former the tubercle is broken and aborted; while in the latter it is merely the extreme edge of the blade that has abnormally grown in advance, and not the tubercle itself that is placed posteriorly.

the whole of the premolars are extremely low. In pm.3 there is a hind talon, but considerably smaller than that of *H. striata*; while there is a mere trace of the anterior talon: the crown forms a regular ellipsoidal cone, which is set obliquely to the molar alveoli, but less so than in *H. striata*; its hinder ridge being within, instead of without, the extremity of pm.4. In pm.2 there is a small hind talon, and, as in pm.3, a distinct cingulum on the hinder half of the inner side: there is no distinct anterior talon, and the tooth is set much less obliquely to the molar alveoli than in *H. striata*; the hind talon being placed opposite the middle of the anterior border of pm.3, instead of entirely on its outer side. A distinct interval occurs between each tooth of the premolar series; whereas in *H. striata* these teeth are in contact. As will be seen from the dimensions given below, the premolars are relatively slightly narrower than in that species. The canine is too battered for description.

Before proceeding to the consideration of the skull itself, it will be simpler to give its dimensions, which are compared below with those of *H. striata* and *H. macrostoma*.

	<i>H. striata.</i>	<i>H. sivalensis.</i>	<i>H. macrostoma.</i>
Width of palate at <u>pm.4</u>	3.5	3.5	3.7
" " " " 3	3.22	2.6	2.8
" " " " behind canine	2.0	1.76	1.83
Interval between anterior border of foramen magnum and canine	7.05	6.6	8.04
" " " " canine and middle of postorbital process of frontal	3.6	3.49	4.2
" " " " postorbital process of frontal and occipital condyle	5.2	4.2 ¹	
" " " " posterior border of palate and canine	3.46	3.02	4.13
Width at postorbital processes	3.07	2.25 ²	2.79
" " " " below "	2.06	1.75	2.39
Interval between canines	1.2	1.18	1.18
" " " " hinder border of <u>pm.4</u> and canine	2.87	2.5	3.46
" " " " canine and <u>pm.2</u>	0.42	0.25	0.6
Length of <u>pm.2</u>	0.68	0.58	0.63 (alv.)
Width " " "	0.45	0.39	0.35 "
Length " " 3	0.88	0.78	0.9 "
Width " " "	0.6	0.47	0.46 "
Length " " 4	1.2	1.16	1.31 "
Transverse diameter of <u>m.1</u>	0.58	0.57	0.62
Ant.-post. " " " "	0.26	0.28	0.3

It will be seen from these dimensions that the present skull is considerably smaller than either of the other two; and that it differs from the skull of *H. macrostoma* by being shorter and wider (as is well shown by the proportions of the palate), and by its shorter and broader premolars. In general form it has a strong general resemblance to the skull of *H. striata*; but the facial portion is somewhat longer in proportion to the cranial, and the facial profile rather more concave.³ On the superior aspect the two skulls are very similar; the postorbital processes of the frontal, though broken in the fossil specimen, having, when complete, been very like those of the living species. The curvature and extent of the temporal ridges are also very similar in the two: but the frontals of the fossil are slightly concave, in

¹ Taken from the original figure.

³ Compare the figures in the "F.A.S." or "Pal. Mem."

² Broken.

place of convex. The occipital crest is smaller in the fossil, but in another specimen is as well developed as in the living species. Allowing for this difference, the occipital surfaces of the two are also very similar.¹ On the inferior aspect the opening of the posterior nares has the same shape in both; and the general form of the palate is also very similar, although owing to the position of m. 1 in the fossil the extension of the palate behind pm. 4 is greater than in the recent species. The postglenoid process of the former extends farther forwards.

Second cranium.—In the British Museum there is another cranium of a small Siwalik hyæna (No. 37,136), represented ($\frac{1}{2}$) in plate K, figs. 4, 4a, 4b, of the "F.A.S.," agreeing in all respects with the specimen described above. It has been somewhat damaged by rolling, and comprehends the greater part of the skull as far back as the middle of the brain-case, where it is broken off by an oblique fracture. The teeth are much worn and broken, but the whole of the four premolars are present; and the left pm. 4 exhibits clearly the sub-equality in size of its three lobes. The superior aspect is extremely like that of the skull of *H. striata*; and the large postorbital processes of the frontals are well displayed, and in conjunction with the opposite zygomatic processes, enclose a large portion of the hinder border of the orbit.

Third cranium.—In figures 3, 3a, 3b, of the plate last quoted there is represented ($\frac{1}{2}$) the hinder half of a third skull of a small Siwalik hyæna, also in the British Museum (No. 37,134): this specimen agrees precisely in size and general form with the two skulls noticed above, and doubtless belongs to the same species. It exhibits the sagittal crest more fully developed than in the type skull; and is therefore nearer to *H. striata*.

Mandible.—In plates XXXVIII., fig. 5, and XXXIX., fig. 7, there are given two views of a nearly complete left ramus of the mandible of a Siwalik hyæna in the British Museum,² differing from the mandibles of either of the three preceding species. The specimen is complete, with the exception of the summit of the coronoid process; and shows the whole of the dentition; the cheek-teeth being much worn, and the greater part of the crown of the canine broken away. A fragment of the right ramus is attached to the symphysis; while the condyle is still clasped by the glenoid fossa, which has been torn away from the skull.

In figures 2 and 5 of the two plates mentioned above there is represented the hinder portion of the right ramus of a precisely similar mandible, collected by Mr. Theobald in the Siwaliks of Asnot, Punjab. It contains two teeth,—*viz.*, pm. 4 and m. 1, which being but slightly worn are in a better condition for comparison than those of the first specimen, and it will accordingly be better to describe the two specimens together.

In the British Museum specimen there are four cheek-teeth; namely, pm. 2, pm. 3, pm. 4, and m. 1: there being no trace of pm. 1 or m. 2; and the number of

¹ Compare the figures in the "F.A.S.," or "Pal. Mem."

² This specimen is also represented in "F.A.S.," plate M, figs 2, 2a.

teeth being consequently the same as in living hyænas. In the other specimen (plate XXXIX., fig. 5), however, there is behind $\overline{m.1}$ the circular alveolus of a small $\overline{m.2}$, which is normally wanting in most other forms. In this specimen, $\overline{m.1}$ has a large talon (the summit broken), and a relatively small blade, on the inner side of the hinder lobe of which there is a small cusp. The form of this tooth shows that the mandibles under consideration¹ belong to a species of *Hyæna*, having carnassial teeth of the type of those of *H. striata*; and presenting, therefore, no sort of affinity with *H. felinus* and *H. colvini*. Before proceeding with the description of the specimens their dimensions may be given, and compared with those of *H. striata*² and *H. macrostoma* :—

	H. striata.	Specimens.		H. macrostoma.
		B. M.	I. M.	
Length of pm. 2	0.62	0.53		0.56 (?)
Width „ „ „	0.32	0.31		
Length „ „ 3	0.72	0.74		0.8
Width „ „ „	0.5	0.41		0.43
Length „ „ 4	0.78	0.8	0.83	0.98
Width „ „ „	0.48	0.42	0.44	0.48
Length „ „ $\overline{m.1}$	0.91	0.89	0.88	0.9 (?)
Width „ „ „	0.4	0.44	0.44	
Depth of jaw at $\overline{m.1}$	1.39	1.4	1.36	1.6
„ „ „ pm. 2	1.36	1.3		1.29
Greatest width of ramus at symphysis	0.85	0.7		0.68
Interval between canine and pm. 2	0.45	0.44		0.68
„ „ „ „ $\overline{m.1}$	2.47	2.43		3.0
Space occupied by 4 cheek-teeth	2.68	2.88		
Antero-posterior diameter of canine	0.68	0.56		0.65
„ „ „ „ „ third incisor	0.32	0.26		0.27
Transverse „ „ „ „	0.22	0.2		0.17

It will be seen from this table that the specimens under consideration are distinguished from the mandible of *H. macrostoma* by the much smaller interval between the canine and $\overline{pm.2}$, and by the premolars being absolutely smaller and relatively shorter and wider; being in fact about intermediate between the teeth of that species and *H. striata*. These differences, coupled with the absence of $\overline{pm.1}$ in the specimens under consideration, leave no doubt that they are specifically distinct from *H. macrostoma*. The only species of Siwalik hyæna to which they can, therefore, belong is *H. sivalensis*; and as they agree with the skull of that species in having carnassials of the striatine type, in their premolars being relatively somewhat narrower than those of *H. striata*, and in the shortness of the diastema, while the British Museum mandible corresponds precisely in size to the type skull of *H. sivalensis*, it is practically certain that the mandibles under consideration belong to that species.

Resuming the description of the lower teeth, the inner cusp of $\overline{m.1}$ of *H. sivalensis* is rather smaller, and placed slightly farther back than in *H. striata*;

¹ The British Museum specimen of this tooth is too worn to show its characteristic points.

² The dimensions of this species are means, and rather smaller than those of the skull of that species given in the preceding table.

causing the ' cusp-line ' to be oblique, instead of transverse. As in *H. striata*, there is a well-marked cingulum on the outer side of the anterior lobe of the blade; and, as in that species, this cingulum becomes perforated at an early stage by the attrition of $\overline{\text{pm. 4}}$. The talon of the former tooth is proportionately larger than in *H. striata*. The last premolar has its anterior talon rather smaller than in that species; and very much smaller than in *H. macrostoma*; the cingulum on the inner side of the hind talon having a more distinct cusp than in either of the other forms. In the two preceding teeth the anterior talons also appear slightly smaller than in *H. striata*; while the width of $\overline{\text{pm. 3}}$ is less, instead of greater, than that of $\overline{\text{pm. 4}}$. The incisors and canine are smaller than those of *H. striata* or *H. macrostoma*; and the middle incisor is not thrust above the level of the other two.

Another specimen of the anterior part of the right ramus of the mandible, figured in "F.A.S.," plate M, figs. 4, 4a, showing the incisors, canine, and early premolars, appears to belong to the present species.

Distinctness and affinities.—In the preceding description it has been shown that *H. sivalensis* is a species showing affinity only with those species whose teeth are formed on the plan of those of *H. striata*; its specific distinctness from the latter having been already sufficiently indicated. *H. brunnea* is in the main distinguished by the same characters: the talons of the premolars are, however, smaller, and, therefore, more like those of the fossil; while $\overline{\text{m. 1}}$ is, at all events in some instances,¹ placed slightly behind $\overline{\text{pm. 4}}$, and thereby approximates to *H. sivalensis*, although always of much smaller size: the inner cusp of $\overline{\text{m. 1}}$ is also more like that of the fossil, being smaller, and placed farther back than in *H. striata*²: the talon of this tooth is, however, smaller than in that species, and therefore different from the fossil. Many of the points distinguishing the latter from *H. macrostoma* have already been pointed out; but it may be added that in *H. sivalensis* $\overline{\text{m. 1}}$ is relatively larger; the premolars shorter and wider; the intervals between the canines and $\overline{\text{pm. 1}}$ and $\overline{\text{pm. 2}}$ shorter; the palate shorter and narrower (especially anteriorly), and the opening of the posterior nares ellipsoidal instead of triangular; and $\overline{\text{pm. 1}}$ absent. On the superior aspect the postorbital processes of the frontals are considerably more developed, and the orbit consequently less open posteriorly; while the temporal ridges make a more sudden curve towards the middle line, and unite more anteriorly to form a better developed sagittal crest. It is not known whether $\overline{\text{m. 2}}$ was present in *H. macrostoma*. The present species is probably distinguished by the same characters from *H. chaeritis*: while from *H. arvernensis* it is distinguished by the same points as from *H. striata*. In all the other species mentioned in the list on pp. 276-7 there is no inner cusp to $\overline{\text{m. 1}}$.

In *H. græca*,³ however, $\overline{\text{m. 2}}$ is present, and $\overline{\text{m. 1}}$ unusually large; on account of which it has been referred to the distinct genus *Hyenictis*. The absence of any trace

¹ See De Blainville, "Ostéographie," Genus Hyæna, pl. III. (*H. fœva*).

² *Ibid.*, pl. VI. (*H. fœva*).

³ See Gaudry, "Animaux Fossiles et Géologie de l'Attique," pl. XV., figs. 6-8.

of the inner cusp of $\overline{m.1}$ sufficiently distinguishes that species¹; which also differs by $\overline{m.1}$ being placed entirely on the inner side of $\overline{pm.4}$, and by the larger and more regularly conical premolars, and the presence of $\overline{pm.1}$. The presence of $\overline{m.2}$ in one of the mandibles of the present form, and its absence in the other, leads to the conclusion that the genus *Hyænicis* cannot be maintained: an inference confirmed by the large size of $\overline{m.1}$ in *H. macrostoma*.

The foregoing comparisons show that the specimens under consideration are entitled to rank as a distinct species; for which the name *H. sivalensis*, Bose, may be retained. In regard to its general affinities, the large size of $\overline{m.1}$ and the occasional presence of $\overline{m.2}$ indicates that the species is a more generalized form than any of the existing hyænas. The form of the carnassials indicates affinity with *H. striata* and *H. brunnea*, while the proportions of the premolars indicate an intermediate stage between those species and the more canoid *H. macrostoma*. The smaller talons of these teeth, and the obliquity of the cusp-line of $\overline{m.1}$ indicate, however, that *H. sivalensis* cannot probably be the direct ancestor of *H. striata*: although it is quite possible that it may occupy that position in regard to *H. brunnea*; and may itself have descended from a stock allied to *H. macrostoma*, in which both $\overline{pm.1}$ and $\overline{m.2}$ were normally present.

Distribution.—The remains described above are all that can be referred to the present species; the range of which extended from the typical Siwalik Hills to the Punjab.

Species (?) 5: *non. det.*

Maxilla.—In figure 4 of plate XXXVA. of this volume there is represented the right maxilla of a Siwalik hyæna in the collection of the British Museum (No. 37,137), which is apparently different from any of those described above.² It shows the four premolars, and the broken alveolus of an elongated $\overline{m.1}$ (*not shown in the figure*); all well worn, and a portion of the enamel of the outer side of $\overline{pm.4}$ being broken away. The carnassial appears to be not unlike that of *H. felina*, though smaller, and with the first lobe rather larger: the tubercle is also large. The two preceding premolars are set less obliquely than in *H. felina*, *H. colvini*, or *H. sivalensis*; and are distinguished from those of *H. macrostoma* by the squarer forms of their crowns. The specimen also differs from *H. felina* by the elongated form of $\overline{m.1}$.³ The teeth are more like those of *H. crocuta* in respect of position; but are distinguished by the larger size of $\overline{m.1}$, the smaller third lobe of $\overline{pm.4}$, and the less distinctly marked 'triangle' of $\overline{pm.3}$. The carnassial, though larger, is more like the corresponding tooth in *H. striata*, or *H. brunnea*; but the form or position of the preceding teeth is different. *H. eximia* is distinguished by the form of $\overline{pm.4}$.

Although it appears highly probable that the present specimen really belongs to a fifth Siwalik species, it appears desirable to await additional materials before naming it.

¹ This cusp is present in the deciduous carnassial.

³ Shown in the original figures.

² Also figured in "F.A.S.," suppl. plate L., figs. 6, 6a: the figures in pl. XXXVA. are reversed.

Other unnamed specimens.—In the course of the preceding descriptions nearly all the accessible remains of Siwalik hyænas have been, at all events provisionally, named. There are, however, in the British Museum (Nos. 16,583; 39,138; and 39,179) three specimens of the muzzles of Siwalik hyænas¹ which are not specifically determinable. The same collection also contains a few undetermined detached teeth; and there are some fragmentary mandibles in the Ipswich Museum, probably belonging either to *H. colvini* or *H. felina*. It is noteworthy that, with the exception of a few metapodials and phalangeals, no limb-bones have been obtained from the Siwaliks that can be referred to hyænas;—indicating the great rarity of carnivorous remains.

MUTUAL AFFINITIES OF THE SPECIES OF HYÆNA.

As the hyænas from the Siwaliks are so strongly represented in species it will be advisable in conclusion to cast a brief glance at their general relations to the other species, and the mutual affinities of the whole number. For this purpose the Siwalik species have been incorporated below in the list given on page 278; the order of arrangement following as far as possible the relative specialization of the dentition; the most highly specialized forms being placed at the top, and doubtful species indicated by an asterisk:—

	3rd lobe, $\overline{pm.4}$	$\overline{m.1}$	$\overline{pm.1}$	$\overline{m.1}$		$\overline{m.2}$
				cusps	talon	
<i>H. crocuta</i> (inner cusp absent in $\overline{mm.4}$)	large	small	absent	absent	small	absent
* <i>H. perrieri</i>	"	"	"	"	"	"
<i>H. colvini</i> ($\overline{pm.1}$ absent)	{ generally smaller }	{ medium, to large	"	"	"	"
<i>H. felina</i> ($\overline{pm.1}$ sometimes absent)		small	"	"	larger	;
<i>H. eximia</i> (tubercle of $\overline{pm.4}$ very small, $\overline{pm.1}$ in one instance wanting)	"	large	present	"	large	"
<i>H. brevirostris</i>	"	"	?	"	"	"
<i>H. græca</i> (inner cusp present in $\overline{mm.4}$)	"	very large	present	"	"	present
<i>H. brunnea</i> (inner cusp of $\overline{m.1}$ small)	small	large	absent	present	large	absent
* <i>H. arvemensis</i> (inner cusp of $\overline{m.1}$ large)	"	"	"	"	larger	"
<i>H. striata</i>	"	"	"	"	"	"
<i>H. sivalensis</i> (inner cusp of $\overline{m.1}$ small: premolars somewhat elongated)	"	very large	"	"	very large	{ sometimes present
<i>H. macrostoma</i> (premolars much elongated)	"	"	present	present?	?	?
<i>H. chareti</i>	"	"	?	present	very large	?

It will be seen from this table that, although the species cannot, in all respects, be arranged in a regular series, the specialization of the dentition advances on the following lines:—first, in the gradual proportionate increase of the third lobe of $\overline{pm.4}$; second, in the decrease in size of $\overline{m.1}$; third, in the disappearance of $\overline{pm.1}$ and $\overline{m.2}$; fourth, in the diminution of the talon, and the diminution and eventually disappearance of the inner cusp of $\overline{m.1}$; which, however, lingers longer in $\overline{mm.4}$; fifth, in the proportionately increasing width of the premolars. The carnassials also become larger in proportion to the other teeth (*megalacrodontism*).

¹ "F.A.S.," suppl. plate L., figs 1, 1a; 2, 2a, 2b; 3, 3a, 3b.

As special characters of particular forms, which are not found in other highly specialized species, may be mentioned the suppression of $\overline{\text{pm.1}}$, and of the tubercle of $\overline{\text{pm.4}}$. The great development of the talons of the premolars which occurs in the most generalized forms is not continued above *H. striata*; and it is noteworthy that in *H. græcu*, which retains the generalized character of a large $\overline{\text{m.1}}$ and the presence of $\overline{\text{pm.1}}$ and $\overline{\text{m.2}}$, $\overline{\text{m.1}}$ has lost its inner cusp.

It will be observed from the description of the dentition of those groups that an almost precisely analogous series of developments occurs among the dogs and the cats, and to a minor extent among the bears; and it will, therefore, be apparent, as has been already mentioned, that these developments must have occurred independently of one another; as if the different groups had been, so to speak, running a race along similar parallel roads to similar common goals, which all had attained. Although the dentition of the more generalized hyænas is, with the exception of the absence of $\overline{\text{m.2}}$, very similar to that of *Ictitherium* (which is probably near the original ancestry of the group); while in the suppression of certain teeth and the form of the carnassials the higher forms are more like the higher *Felidæ*, the fact that the precarnassial cheek-teeth of the latter are always of the elongated form characteristic of the most generalized hyænas, proves that the higher hyænas are genetically entirely distinct from the *Felidæ*. The relationship between the lowest hyænas and *Ictitherium* is so extremely intimate that it may be well doubted whether it is possible to draw any valid distinction between the *Hyænidæ* and the *Viverridæ*; while the genus *Lepthyœna* brings the *Hyænidæ* into close connection with the *Felidæ*.

With regard to the mutual genetic relations of the hyænas, it has already been mentioned that *H. sivalensis* may have belonged to the direct parental stock of *H. brunnea*, which it connects with the generalized *H. macrostoma*: beyond this, however, it cannot be said that there is a probability of any one species in the foregoing list being the direct ancestor of another. The minute gradations occurring between many of these forms leave, however, little room for doubt that they have taken origin from a common stock, somewhat after the order in which they are arranged above; and afford as good an instance of progressive modification as can be found among any group of the Mammalia.

It is worthy of note in connection with the canoid characters of the skull of *H. macrostoma* that the hinder premolars of the mandible have a marked resemblance to those of the S. African *Lycæon*, in which there is a distinct anterior talon to $\overline{\text{pm.4}}$, generally wanting in the dogs, though present in the so-called hyænoid wolf of Sprintsail cave,¹ and in a less degree in some of the domestic races.

¹ "Pal. Mem.," vol. II., pl. 36.

GENUS II: LEPHYÆNA, n. gen., *nobis*.Species: LEPHYÆNA SIVALENSIS, *nobis*.Syn. *Ictitherium sivalense*, *nobis*.

History.—The present genus is mentioned here for the first time; the specimen of a mandible on which it is founded having been previously referred to *Ictitherium*; and mentioned in the "Records" under the name of *I. sivalense*.

Mandible.—The mandible mentioned above, consisting of two fragments of the rami of opposite sides, is represented in figures 8, 9, and 9a, of plate XLV.; and was obtained by Mr. Theobald from the Siwaliks of Asnot, Punjab. The larger fragment (figs. 9, 9a) comprehends the hinder part of the left ramus, wanting the condyle, and coronoid and angular processes; and showing the broken $\overline{\text{pm. 4}}$, $\overline{\text{m. 1}}$ broken posteriorly, and the alveolus of $\overline{\text{m. 2}}$. The other portion (fig. 8) shows the broken $\overline{\text{pm. 3}}$ and the perfect $\overline{\text{pm. 4}}$. All the teeth are considerably worn. The premolars are sub-conical elongated teeth, with a well-marked cingulum on the outer side, a large hind talon, and a rudimentary fore talon. The carnassial has a large blade, of which the anterior lobe is the longer; having a distinct inner cusp placed exactly opposite the hinder lobe of the blade, to which it is closely attached; and a relatively small talon, of which the summit is broken away: there is a small cingulum on the outer side of the anterior lobe; and the length of the whole tooth is not greatly in excess of that of $\overline{\text{pm. 4}}$. The alveolus of $\overline{\text{m. 2}}$ is single and circular; showing that this tooth must have been very small. The jaw is of great vertical depth—much exceeding in this respect the length of $\overline{\text{m. 1}}$; it tapers anteriorly, is much compressed from side to side, and its inferior border ascends very rapidly towards the angular process. The length of $\overline{\text{pm. 4}}$ is 0·57, that of $\overline{\text{m. 1}}$ 0·7, and the greatest depth of the jaw 0·97 inch.

The number of the hinder cheek-teeth is the same as in the *Mustelide*, many of the *Viverride*, and the primitive hyænas and cats; and the character of the teeth shows clearly enough that it is only to one of those groups that the specimen can have any affinity. With regard to the first, the teeth are somewhat like those of *Martes* and *Mustela*; but the anterior lobe of the blade of $\overline{\text{m. 1}}$ is relatively larger in the fossil, and the talon much smaller. In the recent forms, moreover, the length of $\overline{\text{m. 1}}$ is equal to the united lengths of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$; and the talon of $\overline{\text{m. 1}}$ is of a sectorial nature. In no existing viverrine (with the exception of *Cryptoprocta*, in which the inner cusp of $\overline{\text{m. 1}}$ is wanting) are the talon and inner cusp of $\overline{\text{m. 1}}$ relatively so small, and the jaw so deep as in the fossil. In *Ictitherium* (to which the fossil was referred) $\overline{\text{m. 2}}$ is an elongated tooth; the talon of $\overline{\text{m. 1}}$ longer; the whole of that tooth longer in proportion to $\overline{\text{pm. 4}}$; and the jaw less deep.

Coming to the hyænas, a much closer resemblance will be found. If the lower jaw of *H. sivalensis* represented in pl. XXXVIII., fig. 2, and pl. XXXIX., fig. 5, be

compared with the present specimen, it will be found that the two agree in the general form of the jaw (especially in respect of depth, and the upward bend of the inferior border near the angle); in the proportionate length of $\overline{\text{pm. 4}}$ and $\overline{\text{m. 1}}$; and in the general form of these teeth. The main points of distinction, in addition to size, being that the talon of $\overline{\text{m. 1}}$ is relatively smaller in the present specimen, and the inner cusp considerably larger and placed more exactly opposite the hinder lobe of the blade; while the fore talon of $\overline{\text{pm. 4}}$ is relatively smaller; and that tooth scarcely diminishes in width anteriorly.

The fossil resembles some of the primitive cats' in having a talon and inner cusp to $\overline{\text{m. 1}}$; but differs from them in the shape of the hinder part of the jaw; and (with the exception of a species described below) in the greater depth of jaw, in the subequality in size of $\overline{\text{pm. 4}}$ and $\overline{\text{m. 1}}$, and, perhaps, in the larger size of the inner cusp.

Affinities.—From the foregoing comparisons it appears that the present form is most nearly allied to one of the primitive hyænas; from which, however, its small size and the differences noticed above probably indicate generic distinction. The resemblances between the two are, however, so close that it is probable the fossil should be referred to the *Hyænidæ*; and accordingly the new generic name *Lepthyæna* is proposed for it. The smaller size of the talon of $\overline{\text{m. 1}}$, and the fore talon of $\overline{\text{pm. 4}}$ in *Lepthyæna*, probably indicates that this genus is not an ancestor of *Hyæna*, but that it more probably diverged from some form like *Ictitherium*; and may possibly be related to the ancestral stock of the primitive cats; one of which will be shown below to present strong resemblances to the present genus. The number of lower premolars in the latter is unknown.

FAMILY V.: FELIDÆ.

Extent.—In classifying the most specialized group of carnivores which may be collectively spoken of as "cats," Prof. Cope³ divides them into two distinct families, termed the *Nimravidæ* and *Felidæ*: the distinctions between the two being mainly founded on modifications of the basi-cranial foramina. Partly owing to the fact that these foramina have not been observed in all the species, and partly from the gradual transition in other characters from one genus to another, Prof. Mivart⁴ prefers to class the whole of these animals in the one family *Felidæ*; and this course will be adopted here. There is, however, still some doubt as to the number of genera that should be included in the family, since Prof. Cope includes in his *Nimravidæ* the genus *Proaelurus*, Filh.; while Prof. Mivart⁴ is inclined to refer it to the mustelines. Its dentition is, however, decidedly feline; while the form of its skull, though more weasel-like, is not so far removed from that of *Archaelurus*, as to preclude in the present writer's opinion the possibility of its belonging to the *Felidæ*; of which in any case it must probably be regarded as an ancestral form. Provisionally including this genus, the genera of *Felidæ* hitherto described may be tabulated as follows, viz.:—

¹ *Vide infra.*

² 'Amer. Nat.,' vol. XIV., 1880, p. 833, *et. seq.*

³ "The Cat," p. 439.

⁴ *Ibid.*, p. 433.

FAMILY FELIDÆ.

Carnassials well developed: not more than one upper true molar, or two lower true molars.

	No. of premolars.	No. of molars.	Junction of anterior and lateral faces of mandible.	Descending sym-physal expansion.	Canine.	m. 1.		pm. 4.	
						Inner cusp.	Talon.	First lobe.	Inner tubercle.
1 <i>Proaelurus</i>	$\frac{1}{2}$	$\frac{1}{2}$	rounded	absent	smooth	present	present	absent	large
2 <i>Pseudaelurus</i>	$\frac{3}{4}$ (3-4)	$\frac{1}{2}$ (1-2)	"	"	"	absent	"	present?	"
3 <i>Archaelurus</i>	$\frac{3}{4}$	$\frac{1}{2}$	angulated	"	"	"	"	absent	"
4 <i>Elurogale</i>	$\frac{3}{4}$ (3-4)	$\frac{1}{2}$ (1-2)	"	"	serrated	"	"	"	"
5 <i>Nimravus</i>	$\frac{3}{4}$	$\frac{1}{2}$	"	"	"	"	"	"	"
6 <i>Dinictis</i>	$\frac{3}{4}$	$\frac{1}{2}$	"	present	"	present	"	"	"
7 <i>Pogonodon</i>	$\frac{3}{4}$	$\frac{1}{2}$	"	"	"	absent	"	"	"
8 <i>Hoplophoneus</i>	$\frac{2}{3}$ (2-3)	$\frac{1}{2}$	"	"	"	present	"	rudimentary	"
9 <i>Felis</i>	$\frac{1}{2}$ (1-2)	$\frac{1}{2}$	rounded	absent	smooth	absent	absent	present	"
10 <i>Cynaelurus</i>	$\frac{3}{4}$	$\frac{1}{2}$	"	"	"	"	"	"	rudimentary
11 <i>Elurodon</i>	?	?	?	?	?	?	?	"	"
12 <i>Machærodus</i>	$\frac{1}{2}$ (1-2)	$\frac{1}{2}$	angulated	present	serrated	absent	absent	"	large
13 <i>Eusmilus</i> (incisors $\frac{1}{2}$)	$\frac{1}{2}$	$\frac{1}{2}$	"	"	"	"	present	?	?

In the foregoing table the writer follows Prof. Mivart¹ in referring all existing cats to the genera *Felis* and *Cynaelurus*. In opposition to that authority *Pseudaelurus* is, however, placed among the lowest forms, instead of next to *Felis*: a position to which it seems entitled by the large number of premolars sometimes present,² as well as by the well-developed talon of m. 1:³ according to Prof. Cope, the first lobe of the blade of pm. 4 is absent, but this apparently is not the case in the specimen figured by Gervais. The form of the two mandibles does not seem to bear out



Fig. 15. *Machærodus neogaeus* (Lund): cranium, much reduced: pleistocene, S. America.

of his *Nimravidae*. Its high specialization is indicated by the suppression of

¹ *Op. cit.*, p. 431.—⁴ *Pro. Zool. Soc.*, 1882, pp. 140-2.

² For the variation in the number of teeth in *Pseudaelurus* and *Elurogale* see Filhol, "Mémoires sur quelques Mammifères Fossiles des Phosphorites du Quercy," p. 84, *et. seq.*

³ See Filhol, "Phosphorites du Quercy," p. 167. ⁴ "The Cat," p. 435. ⁵ *Ibid.*, p. 437. ⁶ *Op. cit.*, p. 841.

one lower incisor, and the enormous development of the descending mandibular expansion: in the presence of a talon to $\overline{m.1}$ it retains, however, evidence of its affinity to the more generalized cats, which is lost in the other machærodonts. In *Machærodus* the inner tubercle of $\underline{pm.4}$ is always less developed than in *Felis*; and in some cases may be almost or entirely absent: when present it is situated farther back than in the latter. The upper canines are distinguished from those of *Felis*, by their compressed form, serrated edges, and the absence of the vertical grooves which almost always occur in the latter. The outer upper incisor has serrated edges in some instances.

It must be understood that it is impossible to arrange the *Felidæ* strictly in one lineal series; since it is pretty certain that the cheetahs, true cats, and machærodonts form three diverging branches from the primitive stock. Even, however, in the face of this impossibility, the genera, as arranged above, exhibit on the whole a progressive advance in the structure of the carnassials; and in the diminution in number of the premolars and lower molars. The presence of a talon and inner cusp to $\overline{m.1}$ in many of the lower forms, and the absence of a first lobe to $\underline{pm.4}$ are characters connecting the family with the *Viverridæ*, and possibly (if the musteline affinities of *Proailurus* and *Stenoplesictis* are rightly determined) with the *Mustelidæ*. As it is certain that the higher species did not descend from the lower cats through the intervention of the hyænas,¹ it is clear that the development of the first lobe of $\underline{pm.4}$ in *Felis* is another instance of the separate origin of this part.

In the otherwise generalized genus *Cynælurus*, as well as in *Machærodus* and *Ælurodon* the specialization of $\underline{pm.4}$, by the abortion of its inner tubercle, is analogous to the condition prevailing in *Icticyon* among the dogs.

Although the number of lower teeth in *Felis* is generally very constant, yet the present writer has recorded² one instance of the presence of $\underline{pm.2}$ in *F. tigris*, while De Blainville³ has figured a lower jaw of *F. lynx* in which $\underline{m.2}$ is present. Both these instances are probably to be regarded in the light of reversions; and the second instance is very noteworthy, since the lynx in the retention of a rudiment of the talon of $\overline{m.1}$ exhibits a connection with the primitive feline stock more clearly than any other existing cats⁴; the cheetah (*Cynælurus*) coming next in this respect.

In describing the Indian fossil remains of the family it has been found impossible to associate with any certainty the various limb-bones with the skulls, jaws, and teeth, and it has accordingly been thought better to define the various species on the evidence of the latter, and subsequently to describe all the limb-bones together; with suggestions as to the species to which they may probably belong.

¹ Vide *supra*, p. 311.

² 'Journ. As. Soc. Beng.', vol. XLVII., pt. II., p. 2, pl. II. The specimen is compared to *Pseudailurus*, the writer not being then aware of the distinctive characters of $\overline{m.1}$ in that genus.

³ "Ostéographie," Genus *Felis*, pl. XIV.

⁴ Mivart, 'Trans. Zool. Soc. Lon.', vol. X., p. 81; Owen, "Odontography," p. 488.

GENUS I.: *ÆLUROPSIS*, n. gen., *nobis*.Species: *ÆLUROPSIS ANNECTANS*, *nobis*.*History*.—The present genus and species are mentioned here for the first time.

Mandible.—In figures 4, 4a of plate XXXIII. there is represented, from the dental and inner aspects, the hinder part of the right ramus of a carnivore, collected by Mr. Theobald in the Siwaliks of Asnot. The specimen is broken off posteriorly at the commencement of the masseteric fossa, and anteriorly in front of the alveolus of $\overline{\text{pm}}\ 3$: it shows the complete unworn $\overline{\text{pm}}\ 4$, the broken $\overline{\text{m}}\ 1$, and the alveolus of $\overline{\text{m}}\ 2$; that of $\overline{\text{pm}}\ 3$ being concealed by matrix. The number of the hinder cheek-teeth is the same as in *Lepthyæna*; and the form of these teeth is also very similar in the two. Thus the alveolus of $\overline{\text{m}}\ 2$ is single, and circular; while in $\overline{\text{m}}\ 1$ there is a large talon, and the form of the broken base of the blade shows that it was furnished with an inner cusp of much the same shape as in the latter: the whole tooth is, however, shorter, its length being less than that of $\overline{\text{pm}}\ 4$. The latter tooth is extremely long and narrow; with a sharp, compressed main lobe, well-developed fore-and-aft talons, and a large posterior cingulum. The jaw is of great vertical depth; this diameter being nearly equal to the united length of $\overline{\text{pm}}\ 4$ and $\overline{\text{m}}\ 1$. Its inferior border is convex posteriorly, but concave towards the middle; with a distinct commencement of a downward symphyseal expansion at the point of fracture; there is also a marked lateral thickening at this point (fig. 4), indicating the commencement of the symphysis, and that the earlier premolars were probably suppressed. The mental foramen is large and single, as is often the case in *Machærodus*.

The dimensions of the specimen are as follows, *viz.*:—

Length of $\overline{\text{pm}}\ 4$	0·69	Depth of jaw at $\overline{\text{m}}\ 1$	1·35
Width „ „ „	0·23	Thickness of jaw at $\overline{\text{pm}}\ 4$	0·44
Length „ $\overline{\text{m}}\ 1$	0·6	„ „ „ fracture	0·55
Width „ „ „	0·3		

Since an excess in length of $\overline{\text{pm}}\ 4$ over $\overline{\text{m}}\ 1$ is a character only found among some of the existing cats,¹ while the structure of the former tooth is also feline, there is every reason to believe that the specimen belongs to that group. The retention of $\overline{\text{m}}\ 2$ and the appendages of $\overline{\text{m}}\ 1$ indicate, however, affinity with the primitive cats and *Lepthyæna*. In all the American and European primitive cats, in which $\overline{\text{m}}\ 1$ retains its appendages, that tooth is longer than $\overline{\text{pm}}\ 4$, while the depth of jaw is never anything like that of the present specimen. *Lepthyæna* comes, however, a step nearer in this respect. In the presence of a descending symphyseal expansion the jaw under consideration agrees with certain of the primitive cats and *Machærodus*; especially with those species of that genus like *M. palæindicus* (plate XLIV., fig. 3), in which the descending process commences far back, and the jaw itself is of great proportionate depth. The general resemblance between the two (as far as the imperfect condition of the present specimen admits of comparison) is indeed so great

¹ *E.g.*, certain individuals of *Felis pardus* (B. M. No. 115, a).

that it might at first sight appear that the two belonged to the same genus. The *Machærodus*, however, agrees with other species of that genus in the absence of $\overline{\text{m.2}}$, and the talon and inner cusp of $\overline{\text{m.1}}$.

That the present jaw is generically distinct from all other forms is apparent from the foregoing comparisons; which also show that it presents characters connecting the hyænine *Lepthyæna* with the feline *Machærodus palæindicus*. The connection between those two genera is indeed rendered so close that it is probable no well-marked distinction can be drawn between the families *Hyænidæ* and *Felidæ*; and it is not improbable that through an ally of the present form some of the machærodonts may have descended from an ancestral stock intimately related through *Lepthyæna* with the viverroids. The present jaw is provisionally referred to the *Felidæ*, under the new name of *Æluropsis annectans*; and it is much to be hoped that future finds may bring to light other remains of this very interesting form.

GENUS II. : ÆLUROGALE, Filhol.

General.—The main characters of this genus have been given in the table on page 314: it has been hitherto known only by the single species *Æ. intermedia*, Filh., from the Quercy phosphorites; although there is great variation in the size of that species, and it has been divided into the races *major* and *minor*.¹

Species: ÆLUROGALE SIVALENSIS, n. sp., *nobis*.

Syn. *Pseudælurus sivalensis, nobis*.

History.—In 1877 the present writer gave a preliminary notice² of the right ramus of the mandible of a feline carnivore, collected by Mr. Theobald in the Siwaliks of the Punjab, under the name of *Pseudælurus sivalensis*. The more elaborate descriptions of the European forms of that genus, published since that notice was written, have shown that the Siwalik form is generically distinct, and probably belongs to the genus *Ælurogale*; founded subsequently to the original naming of the Siwalik fossil.

Mandible.—The mandible mentioned above is represented of the natural size in plate XLIV., figs. 7, 7a: it is broken off a short distance behind $\overline{\text{m.1}}$; and anteriorly has lost the portion containing the incisive alveoli, and the upper part of the root of the canine. There remains a considerable part of $\overline{\text{m.1}}$; the alveoli of $\overline{\text{pm.4}}$ and $\overline{\text{pm.3}}$; the base of a minute $\overline{\text{pm.2}}$, and part of the root of the canine. Of $\overline{\text{m.1}}$ the anterior lobe of the blade remains perfect, but has its summit abraded: the hinder lobe is broken off, but the elongated shape of its alveolus, and the long interval between the sockets of the two fangs, indicate that this tooth was furnished with a talon: the inner cusp being, however, absent. The alveoli of $\overline{\text{pm.4}}$ and $\overline{\text{pm.3}}$ are of

¹ A second species was named *Æ. mutata*, Filh., but has been subsequently merged with the first (Filh., "Mem. sur quel. Mam. Foss. d. Phos. d. Quercy," p. 8).

² "Records," vol. X., p. 83.

the normal feline type; but the second socket of the former is relatively narrower than in the leopard. The interval between the alveolus of $\overline{\text{pm. 3}}$ and the canine is longer than in most living cats; though not more so than in *F. maercoelis*.¹ Nearly in the middle of this interval there is the broken base of a minute, unicuspid, and probably functionless, $\overline{\text{pm. 2}}$. The section of the canine is apparently of normal size. The inferior border of the jaw is nearly straight throughout the portion remaining, as in most existing cats: the depth of the jaw is also of the same general proportions: the mental foramen is double. Anteriorly the jaw differs very markedly from the jaws of all existing *Felidae*. In place of the outer and anterior faces of the ramus being continuous, and the alveolus of the canine coming close up to the anterior border, these surfaces are nearly at right angles, and separated by a strong vertical ridge, placed far in advance of the alveolus of the canine: the anterior surface of the mandible is consequently concave. Another remarkable feature is that the canine is placed unusually close to the symphysis, which must have been extremely narrow; leaving a very contracted space for the incisors. The superior border of the ramus has a marked upward inclination towards the canine: while between the anterior vertical ridge and $\overline{\text{pm. 3}}$ the outer surface of the jaw is strongly concave.

Comparisons.—The general form of the jaw and $\overline{\text{m. 1}}$ leaves no doubt that the specimen under consideration belongs to the *Felidae*; while the presence of $\overline{\text{pm. 2}}$, the talon of $\overline{\text{m. 1}}$, and the form of the symphyseal extremity, indicates that it is generically distinct from the existing cats, and belongs to the primitive forms of the group. From *Pseudelurus* it is distinguished by the vertical symphyseal ridge; the anterior and lateral surfaces of the mandible being in that genus more or less perfectly continuous. Of the remaining genera² mentioned in the table on p. 314, *Prolaerus* is distinguished by the presence of the inner cusp to $\overline{\text{m. 1}}$; while *Dinictis*, *Pogonodon*, *Hoplophoneus*, *Machærodus*, and *Eusmilus* are distinguished by the descending symphyseal expansion. In *Ninravus*³ $\overline{\text{pm. 2}}$ is wanting, and the superior border of the mandible does not ascend in advance of $\overline{\text{pm. 3}}$. In *Archaelurus*⁴ the mandible is shorter, with a more curved inferior border than in the present specimen: the canines are also relatively short, whereas they were probably long in the latter. There now only remains *Ælurogale*, in which the general characters are the same as in the specimen under consideration; the number of lower premolars being three in the typical race. If the description and figures of *var. major* of that species given by M. Filhol⁵ be compared with those of the present specimen it will be found that there is a very close agreement between them. In speaking of the mandible M. Filhol observes:—"L'espace occupé par les incisives est très-restreint, et c'est à peine s'il existe au niveau de la symphyse une légère place pour loger ces dents qui, au nombre de trois, devaient être très-petites par rapport au volume des autres." And again:—"Le maxillaire

¹ See Mivart, "The Cat," fig. 169, p. 399.

³ Cope, 'Amer. Nat.,' vol. XIV., p. 847.

² The abnormal *Ælurodon* may be disregarded.

⁴ *Ibid.*, p. 842.

⁵ "Phosphorites du Quercy," pp. 260-9, figs. 211-12.

inférieur présente, dans sa partie antérieure, une sorte de face antérieure qui rapelle un peu une disposition que l'on rencontre sur un Félin des phosphorites [*Eusmilus bidentatus*].” These characters are precisely similar to those of the specimen under consideration. In one of the Query specimens¹ $\overline{\text{pm. 2}}$ is an exceedingly minute tooth, placed midway between the canine and $\overline{\text{pm. 3}}$: the interval between the two latter teeth is relatively shorter than in the Siwalik jaw, but in another specimen² it has nearly the same proportion. The jaw of the Query species is deeper than the Siwalik, and its lower margin more curved; but these differences need not be of more than specific value. It is not known whether $\overline{\text{m. 2}}$ was present in the Siwalik jaw, but such was very probably the case.

The resemblance of the Siwalik jaw to *Ælurogale intermedia* is so close that there can be no question that they are closely allied, although specifically distinct; and that they not improbably belong to the same genus. Since it is always preferable to refer a new form to an existing genus till such time as it is proved to be distinct, the Siwalik jaw may be provisionally named *Ælurogale sivalensis*. Although the symphysis of the latter has not a descending expansion, yet its vertical depth, and the marked concavity behind the canine, indicate that the upper canine was relatively long; while the whole form of this part of the jaw presents a considerable resemblance to that of certain species of *Macharodus*. In the following table the dimensions of the specimen are compared with those of *Felis pardus*, *F. isabellina*, and *Ælurogale intermedia*, var. *major*:—

	<i>F. pardus</i> . ³	<i>F. isabellina</i> . ³	<i>Æ. sivalensis</i> .	<i>Æ. intermedia</i> . ⁴	
				a.	b.
Interval between canine and hinder border of m. 1	2.42	1.82	2.65	2.65	3.28
“ “ “ “ pm. 3	0.58	0.37	0.8	0.62	1.11
Space occupied by three cheek-teeth	1.94	1.5	1.92	2.05	2.22
Length of alveolus of pm. 3	0.51	0.4	0.47	0.57	0.67
Width “ “ “ “ “	0.21	0.19	0.19		
Length “ “ “ “ 4	0.6	0.5	0.65	0.68	0.68
Width “ “ “ “ “	0.32	0.2	0.24		
Length “ “ “ “ m. 1	0.73	0.62	0.78	0.72	0.9
Width “ “ “ “ “	0.28	0.24	0.29		
Depth behind canine	1.17	0.94	1.15	1.0	1.5
“ “ “ “ m. 1	0.92	0.64	0.8	0.97	1.22
Antero-posterior diameter of canine	0.68	0.44	0.52	0.38	
Transverse “ “ “ “ “	0.42	0.32	0.32		

Æ. sivalensis is, therefore, intermediate in size between the Tibetan lynx and the leopard. The proportions of the lower premolars are nearer those of the same teeth in the lynx than in the leopard.

¹ Filhol, *op. cit.*, fig. 211.

² *Ibid.*, fig. 212.

³ From specimens in the writer's collection.

⁴ From the specimens figured by M. Filhol.

GENUS III.: FELIS, Linn.

Including *Leo*, *Leopardus*, *Lynx*, *Tigris*, *Uncia*, etc., etc.

Range in time.—The chief dental characters of the genus having been alluded to, and as it is unnecessary to give a list of the recent species,¹ while it would be very difficult to form a correct one of the fossil species, it only remains to mention the distribution in time of the genus. According to Prof. Gaudry² the earliest known appearance of the genus in Europe is in the mid. miocene of Sansan; where it is represented by *F. media*,³ and *F. (?) pygmaea*.⁴ It is represented in the lower pliocene of Montpellier by *F. christoli*⁵; and from that stage appears to increase in numbers till the recent period, in which it probably attained its maximum. In America the earliest species occur in the upper miocene (Loup Fork)⁶; and the genus is henceforth numerous represented.

Species 1: FELIS CRISTATA, Falc. and Caut.

Synonyms: *Uncia cristata*, Cope. *Felis grandicristata*, Bose.

Uncia grandicristata, Cope. (?) *Felis palæotigris*, Falc. (MSS.).

History.—In 1836 Messrs. Falconer and Cautley published a memoir,⁷ illustrated by two small-sized figures,⁸ on the cranium of a large feline carnivore from the Siwaliks, to which they applied the name *F. cristata*. In the "Palæontological Memoirs"⁹ this memoir is reprinted; but by an unfortunate mistake the figure of a skull of a Siwalik hyæna is given in illustration. At a later date Mr. Bose described¹⁰ another large feline cranium in the British Museum, under the provisional name of *F. grandicristata*, not being sure of its distinctness from *F. cristata*; and the present writer subsequently expressed his opinion that the two were the same.¹¹ According to the "Palæontological Memoirs"¹² it appears that Dr. Falconer was latterly inclined to think that there were two species of large Siwalik felines, *F. cristata* and *F. palæotigris*; but it does not appear to what specimen the latter name was intended to apply. The original figure of the superior surface of the cranium of *F. cristata* is given (reversed) by De Blainville.¹³

Type cranium.—The type cranium, obtained by Mr. W. Ewer from the Siwalik Hills, and now in the Museum of the Royal College of Surgeons, is represented in plates XLI. and XLII. of the present volume. It wants the left zygoma (restored in outline), part of the sagittal crest, the auditory bulla, and the crowns of all the

¹ Prof. Mivart ("The Cat") gives the number of living species as 48; with some doubt as to the distinctness of one or two.

² "Les Enchaînements du Monde Animal—Mammifères Tertiaires," p. 5.

³ Lartet, "Notice sur la Colline de Sansan," p. 19.

⁴ *Ibid.*

⁵ Gervais, "Zool. et Pal. Franç.," p. 219.

⁶ Cope, *op. cit.*, pp. 867-8.

⁷ "Asiatic Researches," vol. XIX., p. 135, *et. seq.*

⁸ Plate XXI., figs. 1, 2.

⁹ Vol. I., p. 315.

¹⁰ 'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 127.

¹¹ 'Records,' vol. XIV., p. 64.

¹² Vol. I., p. xxi.

¹³ "Ostéographie," Genus Felis, pl. XV.

teeth; and has also sustained some minor damages, sufficiently apparent in the figures. The incisors had dropped out before the specimen was fossilized; but it appears from Dr. Falconer's memoir that the crowns of the cheek-teeth were originally present, since he alludes to them as indicating that the skull belonged to an adult, though not an aged, individual.

An inspection of the plates will show that the reference of the specimen to the genus *Felis* is correct; and as its large size separates it from all existing cats with the exception of the tiger, the lion, and the jaguar, comparisons may be in the main restricted to those three species. It will simplify these comparisons to take them in the order here mentioned, after first giving the dimensions of the fossil, which are compared below with those of skulls of the tiger and lion. The skull of the latter is a small Asiatic specimen in the Museum of the Royal College of Surgeons; the first tiger skull (a) is an unusually small specimen from Burma, and the second (b) a medium-sized one from India; both in the writer's collection:—

	F. cristata.	F. tigris.		F. leo.
		a.	b.	
Length from inferior margin of foramen magnum to incisive alveoli	8.95	9.2	9.6	9.92
Extreme zygomatic width	7.6	7.3	8.16	7.54
Length from anterior border of nasals to occipital crest	9.2		10.2	
" base of foramen magnum to summit of occipital crest	4.1		3.66	
" incisive alveoli to postorbital process of frontal	5.6	6.08	6.55	6.7
" postorbital process of frontal to hinder border of condyle	6.36		6.2	5.9
Interval between inferior border of foramen magnum and posterior border of palate	4.5	4.05	4.32	
Interval between posterior border of palate and incisive alveoli	4.45	5.15	5.28	
" outer borders of condyles	2.2		2.05	2.2
Vertical diameter of condyle	1.29		1.15	1.25
Width behind canine	3.0	3.05	3.3	3.06
" at pm. 4	4.5	4.6	5.05	4.62
Length of nasals	2.8	3.2	3.3	3.1
Width of frontals across postorbitals	3.1	2.9	3.95	3.38
Height of orbit	2.05	2.19	2.25	2.11
Interval between canine and pm. 3	0.32	0.6	0.46	0.6
Length of pm. 4	1.5	1.3	1.39	1.44
United length of pm. 3 and pm. 4	2.2	2.03	2.22	2.32
Antero-posterior diameter of canine	0.95	0.93	1.06	0.87

Commencing with the tiger, pm. 3 and pm. 4 are described by Dr. Falconer as having the same structure as in that species; the length of the latter tooth being, however, considerably greater. It is also stated that these two teeth were set at a more marked angle. The canine and pm. 3 are placed nearer together than in any tiger: the alveolus of pm. 2 exists on the left side. The measurements show that the fossil is slightly smaller than the lesser tiger's skull; and, therefore, below the average size of that species. It differs from the same skull, and also from the lion's skull, in being proportionately wider; but in this respect its proportions are nearly similar to the larger tiger's skull. It also differs very markedly in that the length of the facial is considerably less than that of the cranial portion, whereas in the tiger the former diameter exceeds the latter.¹ The same relations are exhibited by the

¹ Occasionally in very large tigers, when the parietal region is greatly developed, these two diameters are sub-equal.

base of the skull, in which the portion behind the palate is longer than the palate itself: the reverse obtaining in the tiger. The sagittal crest is much more developed; and according to Dr. Falconer originally extended in a straight line from the frontals to the occipital crest,¹ without the marked depression which always occurs in the tiger.² In consequence of this great development of the sagittal crest the hinder portion of the frontals is more elevated above the level of the post-orbital processes; causing the junction of the facial and cranial elements to form, when viewed in profile, a less marked angle than in the tiger: this character is an approach to that found in some species of *Machairodus* (e.g. *M. neogaeus*). The occipital crest is also deeper, and overhangs the condyles to a greater extent; the condyles themselves being relatively larger. The anterior root of the zygoma is deeper and its inferior

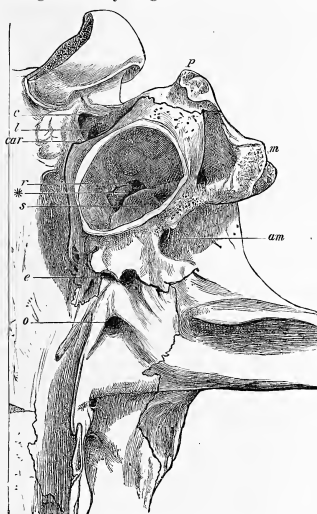


Fig. 16. *Felis tigris*, Linn. Part of the base of the skull, with a portion of the auditory bulla removed: *c*, condylar foramen; *l*, foramen lacerum posticum: *car*, carotid canal; *e*, eustachian canal; *o*, foramen ovale; *p*, paroccipital process; *m*, mastoid process of periotic; *am*, meatus auditorius externus.

border more arched, and placed at a greater distance from the alveoli of the cheek-teeth. The glenoid fossa, in place of having nearly the same antero-posterior width throughout its extent, is considerably expanded in this direction at its outer extremity. In the posterior part of the palatal aspect still more striking differences may be observed. Thus in the fossil the whole periotic region is brought nearer to the glenoid fossa than in the tiger (woodcut fig. 16); this being accompanied by the larger size of the mastoid process (*m*), and (as far as their broken condition admits of determining) of the bulla and paroccipital process (*p*). In consequence of these differences the space, or cavity, behind the glenoid fossa, which in the tiger is open, with a highly inclined anterior wall, becomes much narrower, and more highly arched; with its anterior wall not far removed from the vertical. The position of the various foramina is of necessity different in the two skulls; thus the aperture of the eustachian canal (*e*), in place of being behind the post-glenoid process (*pg*) as in the tiger, is situated on the same transverse line; while the foramen ovale (*o*) instead of being on the line of the post-glenoid process, is considerably in advance of it.

¹ In plate XLII. the dotted profile line should apparently have been straight.

² Compare De Blainville, "Ostéographie," Genus *Felis*, pl. VII.

The skull of the lion¹ is in many respects nearer to the fossil; although it agrees with that of the tiger in the relative proportions of the facial and cranial portions, and the longer interval between the canine and pm.3. In its larger pm.4 the lion comes nearer to the fossil; while in the form of its anterior zygomatic root, and antero-posterior widening of the outer extremity of the glenoid fossa it also agrees with the latter. The profile of the cranium makes, moreover, a somewhat nearer approach to that of the fossil; although there is never the marked rise behind the post-orbitals, and the sagittal crest is less elevated. In the depression of the median nasal and frontal sutures the lion's skull approaches the fossil; although this character is exaggerated in the latter. In respect of the hinder part of the base of the skull the lion is about intermediate between the fossil and the tiger; the eustachian opening being placed nearly on the line of the post-glenoid process, and the whole bulla more approximated to the same than in the tiger. The cavity behind the post-glenoid process is also shorter and more vaulted, with the anterior wall less inclined than in the tiger, but more so than in the fossil.² The mastoid process is, however, much smaller than in the latter. The palate is only slightly longer than the post-palatinal portion, and, therefore, nearer the fossil than in the tiger.

The skull of the jaguar³ in respect of the form of the cranial profile makes the nearest approach to the fossil, especially in old individuals. It is also the only one of the larger existing cats in which, as in the fossil, the facial is considerably shorter than the cranial portion. On the inferior aspect, moreover, the post-palatinal portion is equal in length to the palatal. The relative position of the auditory bulla, and the form of the glenoid fossa, are also very-similar in the two; but the cavity behind the post-glenoid process is more open, and less deep, with its anterior wall more inclined; and the mastoid process is smaller. The skull of the jaguar is also distinguished, apart from its considerably smaller size, and relatively smaller pm.4, by the greater concavity of the frontals behind the post-orbital processes, and by the shorter and wider palate, and excessive width and outward curvature of the zygomae. The great depth of the anterior root of the latter is more pronounced than in the fossil; and exceeds the vertical diameter of the orbit.

Second cranium.—In figure 1 of plate XL. there is represented ($\frac{3}{4}$) the hinder portion of the cranium of a Siwalik *Felis* in the collection of the British Museum, agreeing in size, and in the strongly marked parietal ridges and sagittal crest, so closely with the last specimen that there appears every reason for regarding the two as specifically the same. The sagittal crest is, indeed, somewhat less prominent in the second specimen, but this variation may well be due to differences in age or sex. The specimen has lost the right occipital condyle, and both zygomatic arches, and is

¹ Compare De Blainville, *op. cit.*, pl. V.

² There is some variation in these respects in different skulls: the skull of a small Asiatic specimen in the Museum of the College of Surgeons, and one of a cave lion from Belgium in the same collection (No. 352), coming nearer to the fossil than any other specimens which have come under the writer's notice.

³ Compare De Blainville, *op. cit.*, pl. VIII.

broken off in front at the anterior border of the orbit. It is of considerable importance, since it shows the sutures between the frontals, nasals, and maxillæ. The nasals (*na*) terminate superiorly in a broad arch; reaching to within a very short distance of the point to which the nasal process of the maxilla extends; the termination of the latter (*mx*) being likewise blunted, and the intervening frontal process very short.

In the tiger, the extremity of the nasals is pointed, and the nasal process of the maxilla, which is blunt, never extends up to the level of the former; the average interval between the two being about half-an-inch, and the intervening frontal process long and pointed. In the lion, the sharply pointed extremity of the maxilla extends up to the level of the equally acute nasal extremity; the frontal process being extremely long and pointed. In the jaguar, the relations of these bones are nearly intermediate between the tiger and the lion; the maxillary process being sharper and extending higher up than in the former, but not so far as in the latter. In the leopard, Prof. Owen observes¹ that the relation of these bones is the same as in the tiger, and this is true of many specimens. In some, however (as in a skull from Káshmir in the writer's possession), the blunt maxillary process extends up to the level of the nasals, whose extremity is somewhat rounded; the descending frontal process being comparatively short. This skull comes nearer in this respect to the fossil than any other which has come under the writer's observation.

The length of the present specimen is eight inches; or almost exactly equivalent to the corresponding part of the larger of the two tigers' skulls whose dimensions are given above. The specimen measures 3·3 inches across the post-orbital processes of the frontals: the interval between the latter and the hinder borders of the occipital condyles being 6·4 inches.

Third cranium.—In figure 2 of plate XL. there is given a lateral view of an imperfect cranium of another large *Felis* in the Siwalik collection of the British Museum; which is the specimen already mentioned as having been provisionally named *F. grandicristata* by Mr. Bose, whose description may be quoted:—

"The specimen consists of a cranium deficient in the facial portion in front of the orbits. The zygomatic arches, brain-case, and its base are beautifully preserved. . . . The skull belonged to an animal considerably larger than *F. cristata*, and of about the same size as the larger varieties of the royal tiger. The sagittal crest (slightly damaged posteriorly) is much thicker and more prominent than in *F. cristata*, and stands vertically on the roof of the cranium. Its height anteriorly is six times greater than the corresponding height in the tiger. The ridges which originate from behind the post-orbital processes of the frontals are stronger, and run obliquely to a greater distance than in any other large forms of *Felis*; and these, instead of perfectly blending to form the sagittal crest, run parallel nearly as far as the occiput, forming a narrow and shallow groove along the median

¹ "Brit. Foss. Mam. and Birds," p. 164.

line of that crest. The triangular valley included between the frontal ridges in front of the parietal crest [*sagittal area*], as well as the frontal fossa between the post-orbital apophyses, slopes anteriorly, as in *F. cristata*, and not posteriorly, as in other large *Felidae*. The depth of the mesopterygoid fossa, as well as the length of the basiscranial axis, is very nearly the same as in the larger individuals of the tiger; but the breadth of the cranium at the zygomatic arches is proportionately much smaller than in the latter.”

In the following table the dimensions of this specimen are compared with the corresponding dimensions of the type skull of *F. cristata*, and of the larger of the two tigers’ skulls mentioned on page 321 :—

	<i>F. cristata</i> . (type)	Specimen.	<i>F. tigris</i> .
Interval between inferior border of foramen magnum and posterior border of palate	4·5	5·07	4·32
Depth of mesopterygoid fossa		1·02	0·9
Extreme zygomatic width	7·6	8·42 ¹	8·16
Width of frontals across post-orbitals	3·1	3·36	3·95
Interval between post-orbital process and hinder border of condyle	6·36	6·9	6·2
„ „ outer borders of condyles	2·2	2·46 ²	2·05
Length of pm. 4	1·5	1·45	1·39

The hinder part of the inferior surface of the present specimen has the same characteristic points as the type skull of *F. cristata*, the large mastoid process being especially noticeable. The form and position of the zygoma is also the same in the two; while, as Mr. Bose observes, the frontals have the same concavity, small post-orbital processes, and strong temporal ridges. The only characters of any importance noticed by Mr. Bose as distinguishing the two skulls, are the larger size of the present specimen, and its more strongly developed sagittal crest; but these differences are not greater than those in different individuals of the lion or tiger. The pre-glenoid process of the present specimen is very strongly developed.

In comparing the fossil with the skull of the tiger Mr. Bose concludes that the zygomatic width was less in the former than in the latter; the comparison having been made on the evidence of the post-palatal length of the base of the skull. The dimensions of the type skull of *F. cristata* show, however, that such a comparison gives a false result, owing to the relatively greater length of the post-palatal portion of the fossil skull as compared with that of the tiger. The present specimen was probably not much, if at all, longer than the tiger’s skull with which it is compared above; but had a proportionately wider zygoma, larger occipital condyles, a longer cranial, and (probably) a shorter facial portion, a longer pm. 4, and narrower frontals.

Seeing, therefore, that the present specimen differs from *F. tigris* in precisely the same points as the type skull of *F. cristata*; while it only differs from the latter in characters that need not be of more than individual or sexual value, there is every probability that the two fossil skulls should be referred to the same species; the present specimen having probably belonged to a very old male.

¹ Given by Mr. Bose as 8·12.

² Given by Mr. Bose as 2·77.

Specific distinctness.—The foregoing comparisons clearly show that the present species differs very widely from the tiger; and, though somewhat nearer to the lion, and still nearer to the jaguar, cannot be referred to any existing species. In size it was about equal to average tigers, but was distinguished by its generally stronger skull, as shown by the greater development of the sagittal crest, wider zygomatic arches, larger condyles, stronger glenoid fossa, longer carnassial tooth, and shorter muzzle; and was probably an altogether more powerful animal, showing in this respect an analogy with the jaguar, which in proportion to its size is the most powerful of living cats.

Of fossil species, the cave lion, whether it be regarded with MM. Dawkins and Sandford as identical with *F. leo*, or with MM. Filhol and Bourguignat as a distinct species, differs from the fossil in nearly the same respects as the existing lion. Of the numerous other forms of *Felis* which M. Bourguignat¹ has described from the pleistocene of Europe, the only ones equal in size to the present form are those which he has named *F. (Tigris) edwardsiana* and *F. (T.) europaica*. The former species is founded on the proportions of the body and tail, and the size of certain teeth, which are said to differ from those of *F. spelaea*. The second species is named on the evidence of a humerus and radius. These very problematical species do not, therefore, admit of comparison with the Siwalik form. A fragmentary maxilla of a smaller form which M. Bourguignat designates *F. (Leopardus) brachystoma*² indicates, if the restoration be correct, a palate still shorter than in the Indian fossil. From the later tertiaries of N. America Dr. Leidy³ has described three large felines, on the evidence of detached teeth and fragments of the jaws, and has named them *F. augusta*,⁴ *F. atrox*, and *F. imperialis*. The first was nearly as large as the tiger, the second considerably larger, and the third intermediate between the two. As the upper teeth of the Siwalik fossil are not preserved, it is impossible to compare the latter with the American species.

There does not appear to be any other described species of *Felis* which can be the same as *F. cristatus*; and even if there be such, that name probably has the priority.

Distribution.—The three skulls described above are the only remains which can be certainly referred to the present species; and were all obtained from the typical Siwalik Hills.

Species 2: *FELIS* (? *CYNÆLURUS*) *BRACHYGNATHUS*, n. sp., *nobis*.

History.—In figures 1, 1a, and 2, 2a; of plate XLIII. there are represented two right rami of the mandible of a large feline, in the Siwalik collection of the British Museum (Nos. 16,573 and 16,537), previously figured in the "F.A.S."⁵ under the head of *Machærodus sivalensis*⁶; a reference which has been shown to be incorrect by

¹ "Histoire des Fossiles Fossiles, etc.," Paris, 1879.

² *Op. cit.*, fig. 6.

³ "Extinct Vert. Fauna of Western Territories," pp. 227-8.

⁴ *Errorim, F. augustus*.

⁵ Plate N., figs. 6, 6a; 7, 7a.

⁶ "Pal. Mem.," vol. I., p. 551.

Mr. Bose¹; who referred the specimens to *Felis*, with the suggestion that they might belong to *F. cristata*.

Mandible.—The first of these two specimens is nearly complete up to some distance behind the commencement of the masseteric fossa; and shows three cheek-teeth, all broken; the canine; and two incisors, the first having been broken away. The second specimen shows the three cheek-teeth, of which $\overline{\text{pm. 3}}$ is alone uninjured; and the alveolus of the canine. The form and number of the cheek-teeth is the same as in living cats; while the rounded anterior extremity of the jaw, and the absence of a descending symphysial expansion, are characters of *Felis*, as distinguished from *Machærodus*. The canine and incisors in the first specimen do not appear quite fully protruded; though the condition of the cheek-teeth indicates that the animal to which it belonged was nearly adult. There are no signs of immaturity in the second specimen. In the following table the dimensions of these specimens are compared with those of the mandible of the small tiger mentioned on page 321, and of an Indian leopard in the writer's collection:—

	16,573.	16,537.	<i>F. tigris.</i>	<i>F. pardus.</i>
Length of three cheek-teeth	2.16	2.29	2.32	1.87
Interval between canine and posterior border of m. 1	2.4	2.61	3.26	2.42
" " " " pm. 3	0.25	0.4	0.94	0.6
Depth of jaw at m. 1	1.2	1.2	1.25	0.96
Length of pm. 3	0.52	0.68	0.6	0.49
" " " " 4	0.78	0.78	0.9	0.68
" " " " m. 1	0.9	0.92	0.94	0.78
Antero-posterior diameter of canine	0.55	0.53	0.9	0.55

These dimensions show that the fossil jaws differ from those of both the recent species in the relatively shorter diastema,² and smaller canine. Thus while the cheek-teeth are nearly as large as those of the tiger, the canine is no larger than that of the leopard; and the diastema is considerably shorter than in that species. Another most important difference is that the incisors (fig. 1a) are situated considerably in advance of the canines; instead of entirely, or mainly, between them, as in all other living true cats: this relation being probably due to the very small size of the canines. The crown of $\overline{\text{pm. 3}}$ has small fore-and-aft talons, with the main lobe nearly as tall as m. 4; in both respects differing from the larger cats, and agreeing with some of the smaller species like *F. isabellina*,³ and *F. catus*. In respect of the exceedingly short diastema and small canine, the fossils come nearest to the cheetah (*Cynælurus*),⁴ among living cats; in which alone, as in the fossils, the length of the diastema is not more than half that of $\overline{\text{pm. 3}}$; while the canines have a smaller diameter than those of the lynx, although the carnassials are considerably larger than those of the latter.⁵ In the cheetah, moreover, the anterior border of the

¹ *Op. cit.*, p. 123.

² The incomplete protrusion of the canine in the first specimen tends to make the diastema longer than in a fully adult specimen. The difference in the length of $\overline{\text{pm. 3}}$ in the two specimens cannot be considered more than an individual variation.

³ In *F. lynx* (frequently considered identical with *F. isabellina*) there are large talons to $\overline{\text{pm. 3}}$ (De Blainville, "Ostéographie," Gen. Felis, pl. XIV.)

⁴ De Blainville, *op. cit.*, pls. IX., XIV. Mivart, "The Cat," p. 423, fig. 183.

⁵ Compare De Blainville's figures.

masseteric fossa is, as in the fossils, more sharply defined than in most living cats; while the lower incisors project slightly in front of the canine, although not to such an extent as in the fossils: $\overline{\text{pm. 3}}$ has, however, large fore-and-aft talons, which are wanting in the latter.

The present jaws have their canines and diastemæ too small to permit of their belonging to *F. cristata*.¹ The mandible of *F. arvernensis*, Cr. and Job.,² presents a strong resemblance to the present specimens; having cheek-teeth of the size of a small tiger, but the canine smaller; the incisors projecting beyond the latter; a small diastema; and a sharply defined masseteric fossa. The diastema is, however, not quite so short, while the talons of $\overline{\text{pm. 3}}$ are more developed than in the fossils under consideration; these points being probably indicative of specific distinctness.³ Apparently the only other species to which the present specimens could belong is the little known *F. brachystoma*⁴; but the canine of that form is considerably stouter.

From the foregoing comparisons it is evident that the present specimens indicate the existence in the Siwalik epoch of a feline carnivore nearly as large as a small tiger, but readily distinguished by its shorter jaws and smaller canines. That it presented a very strong resemblance to the living genus *Cynaelurus* is certain; but in the face of certain differences in the form of $\overline{\text{pm. 3}}$, and in the absence of the characteristic $\overline{\text{pm. 4}}$, it would be hazardous to say that it belonged to that genus; and it is therefore safer to refer it provisionally to the typical genus *Felis*; especially since it is not improbable that were the skull of this interesting form known it might exhibit characters common both to *Felis* and *Cynaelurus*, and, in conjunction with *F. arvernensis*, remove the present distinctions between the two. The specific name *brachygnathus* may be appropriately applied to the Siwalik fossil.

Species 3: *FELIS* (*non. det.*; allied to *F. pardus*).

Mandible.—In figures 4, 4a, of plate XLIII. there is represented the hinder portion of the left ramus of the mandible of another Siwalik *Felis*, in the British Museum, apparently indicating a third species of the genus. The specimen shows the three cheek-teeth, of which the two last are considerably damaged; but still sufficiently perfect to show that the specimen belonged to a true *Felis*. The jaw is considerably smaller than that of *F. brachygnathus*, and cannot, therefore, belong to *F. cristata*. It differs from the former in the less well-defined masseteric fossa, in the more distinct talons and lower crown of $\overline{\text{pm. 3}}$; and also in the absence of any sign of the symphysis, which in that species commences a short distance in front of the latter tooth. The diastema of the present specimen was, therefore, probably

¹ The reader may convince himself of the impossibility of these jaws belonging to *F. cristata* by making a tracing of one of the figures and placing it in its proper position on plate XLIII.

² De Blainville, *op. cit.*, pl. XVI.

³ De Blainville was inclined to refer *F. arvernensis* to *F. pardus*: the diastema is, however, relatively shorter, and the crown of $\overline{\text{pm. 3}}$ taller.

⁴ Bourguignat, *op. cit.*, fig. 6.

long. In the size of the cheek-teeth this specimen agrees with the jaw of a medium-sized leopard; in some specimens of which the crown of $\overline{\text{pm. 3}}$ is low, while in others m. 1 is longer than pm. 4 , as is the case in the fossil. The fossil jaw is, however, somewhat deeper than in the leopard.

Since the jaws of the different species of *Felidae* resemble one another so closely, it is almost impossible, except in a few particular instances, to draw from them any characters of specific value; and it is accordingly considered inadvisable to assign any specific name to the present specimen; but to consider it merely as indicating a third Siwalik cat, probably allied to the leopard.

Second specimen.—There is in the British Museum a second specimen of the left ramus of a very similar mandible (No. 48,929), containing the two last cheek-teeth. It is of slightly larger size than the last specimen, but may not improbably be referred to the same species.

Lower canine.—In figure 3 of plate XLIII. there is represented from the outer side the canine tooth of a carnivore, collected by Mr. Theobald in the Siwaliks of the Punjab, which from agreeing with the corresponding tooth of existing cats, may without much doubt be referred to the type genus. From its highly curved shape, and the approximation of the two vertical ridges occupying its inner surface, it evidently belongs to the lower jaw¹; and to the right side. It does not, however, show the vertical grooves which generally occur on the outer side of this tooth in the cats. The summit of the crown has been abraded. In the following table the dimensions of this tooth are compared with those of the canine of the small tiger's skull referred to in the description of the preceding species:—

	Fossil.	F. tigris.
Antero-posterior diameter of base of crown	0.69	0.9
Transverse " " " " "	0.54	0.58
Height of crown (restored in fossil)	1.3	1.45

As the upper canine of *F. cristata* is larger than that of the same skull of *F. tigris*, the present tooth cannot belong to the former. The lower canine of *F. brachygnathus* is considerably smaller than the present specimen. Since the type mandible of the present species is somewhat deeper than that of the leopard, and as the second specimen is rather larger, it is not impossible that the canines of that species may have been somewhat stouter than in the leopard, in which case the specimen under consideration may possibly be referred to the former: if, however, this reference be incorrect it must be referred to a new species. The tooth is about equal in size to the canine of the jaguar.

Distribution.—If all the specimens described above be correctly associated, the range of the present species extended from the typical Siwalik Hills to the Punjab.

Species 4: FELIS (*non. det.*; allied to *F. lynx*).

Mandible.—In figures 7, 7a of plate XLIII. there is represented the anterior part of the left ramus of a small *Felis*, collected by Mr. Theobald in the Siwaliks of

¹ In the figure the specimen is represented as belonging to the upper jaw.

Jabi, Punjab. It shows the hinder portion of the alveolus of the canine, the complete $\overline{\text{pm. 3}}$, and the broken $\overline{\text{pm. 4}}$. In the following table the dimensions of this specimen are compared with those of a mandible of *F. isabellina*, in the writer's possession:—

	Specimen.	<i>F. isabellina</i> .
Interval between canine and posterior border of $\overline{\text{pm. 4}}$	1.2	1.23
Length of diastema	0.34	0.37
" " $\overline{\text{pm. 3}}$	0.35	0.42
Height " " "	0.27	0.28
Length " " 4	0.48	0.52
United length of two premolars	0.83	0.91
Depth of jaw at $\overline{\text{pm. 4}}$	0.63	0.76

These dimensions are so close as to be well within the limits of individual variation; and indicate without much doubt that the fossil belonged to one of the lynxes. Seeing, however, the doubts which still prevail as to the number of the existing species, it would be unwise to attempt to determine the species of the Siwalik form. The talons of $\overline{\text{pm. 3}}$ in the latter are intermediate between those of the isabelline lynx noticed above, and those of the northern lynx figured by De Blainville.¹

Species 5: *FELIS SUBHIMALAYANA*, Bronn.

History.—In 1836 Messrs. Baker and Durand described² the cranium and other remains of a small *Felis* from the Siwaliks, without assigning to them any specific name. In Bronn's "Index Palæontologicus" these specimens are named *F. subhimalayana*³; and this name is accordingly adopted here.

Cranium.—The cranium is represented in figure 1 of plate XXVII. of Messrs. Baker and Durand's memoir, and is now preserved in the Science and Art Museum, Dublin.⁴ It is described as being somewhat, though not extensively mutilated; "the most serious injury which it has sustained (as being the only one affecting the measurements) is a slight crush or compression, which has apparently flattened and perhaps widened the cranium. The proportions between the fossil and the skull of a common-sized wild or jungle cat are as follows:—the length from posterior border of occipital condyle to anterior of canine tooth being taken as the unit or modulus, and those dimensions only being collated in which the greatest differences exist. The two skulls may be understood to correspond in other respects.

	Recent.	Fossil.
" Length from posterior of occipital condyle to anterior of canine, assumed at	1,000	1,000
" Greatest breadth of cranium opposite mastoid processes	508	581
" Height of occiput from lower margin of foramen magnum to top of transverse ridge	301	333
" Breadth across occipital condyles	267	346
" Ditto measured externally across most prominent part of line of molars	427	489
" Height of orbit perpendicular, but measured in plane of orbits margin	289	257

"The differences of proportion exhibited by the foregoing comparison are, as will be seen, very trivial. Setting aside the excess in breadth of the fossil cranium,

¹ *Op. cit.*, pl. XIV.

² 'Journ. Asiat. Soc. Beng.' vol. V., p. 579.

³ *Errorum, subhimalayanus*.

⁴ No. 47, among Dr. Beattie's fossils.

which if not caused is at least exaggerated by the crush before alluded to, there will remain no remarkable points of difference except in the diameter of the orbit, and in the width across the occipital condyles. The other variations probably exceed not what may be detected in the skulls of cats belonging to one species. There are, however, other differences of form not shown by the measurements. In the fossil the post-orbital apophysis is more developed, and the plane of its projection more continuous with that of the frontal bone. The depression of the cranium in rear of this apophysis is more marked, giving a greater width to the temporal fossæ;—the bullæ of the mastoid processes have a more elongated shape, and are generally larger; and the transverse ridge of the occipital bone is higher, sharper, and more prominent. All, or nearly all, these differences tend to show a greater development of the predaceous faculties in the fossil;—a circumstance further confirmed by the teeth, which, though corresponding in form with those of the [jungle] cat, are somewhat longer and stronger.”

In the limited time during which this specimen was under the present writer's observation, the only skull with which it could be compared was one of the domestic cat; with which it was found to agree in size. From this agreement it is inferred that the recent skull with which it was compared by Messrs. Baker and Durand was that of *F. bengalensis*, rather than the larger *F. chaus*; both being commonly known in India as ‘jungle cats.’ The relatively large size of the occipital condyles of the fossil is equally noticeable when compared with the skulls of the domestic cat, *F. catus*, and *F. maniculata*.

The present cranium proves the existence in the Siwaliks of a fifth species of cat, of the size of *F. bengalensis*, but specifically distinct. Although it has not been found practicable to make an exhaustive comparison between the fossil and the skulls of other small cats, yet the Siwalik form is probably specifically distinct, and may retain the name of *F. subhimalayana*.

*Mandible and limb-bones.*¹—In figure 2 of the above-quoted plate of Messrs. Baker and Durand's memoir there are represented certain limb-bones associated with a nearly complete ramus of the mandible of a small cat. The mandible, it is said, “must have belonged to a smaller animal than that which owned the cranium: it presents no difference worthy of note from that of the wild cat. The humerus, tibia, and metatarsal bones forming part of this interesting little group, appear to have belonged to the same individual as the lower jaw; and it is curious enough that their present bond of connection is the plate of a small crocodile. The carpal, metacarpal, and phalangeal bones represented in figure 3 [of the same plate], obtained from the same locality, though at different times, may possibly be assigned to the same or a similar animal.” It is most probable that these specimens belong to the same species as the cranium.

Distribution.—All the remains described above were obtained from the typical Siwalik Hills.

¹ These specimens are also in the Dublin Museum (No. 48).

Species 6: FELIS (?) sp., non. det.

Upper canine.—In figure 5 of plate XLV. there is represented the left upper canine of a small carnivore; which from its flattened inner surface must almost certainly have belonged to some cat-like animal. The summit of the crown has been broken away. The flattened inner surface is bounded by distinct vertical ridges; but the vertical grooves present on both sides of the upper canines of most species of *Felis*, are absent. These grooves are, however, wanting on the inner side of the canines of *F. isabellina*; generally on both sides of those of *F. earaeal*¹; and always in *Cynaelurus*²; so that on this account there is no reason why the specimen should not belong to *Felis*.

Of the known Siwalik cat-like animals the only ones to which the present specimen could possibly belong are (1st) the hyænid *Lepthyæna*; (2nd) *Æluropsis*; (3rd) *Ælurogale*; (4th) *Felis*, sp. 3; (5th) *Felis*, sp. 4; and (6th) *F. subhimalayana*. Of these, Nos. 2, 3, and 4 had canines considerably larger than the present specimen; while in No. 6 the canine is much smaller. Judging from the depth of the jaw of No. 1, it is probable that the canine of that species was larger than the present tooth; and since the canine of the isabelline lynx is also considerably larger, it is probable that the same was the case with the allied No. 5. It, therefore, seems that the tooth under consideration indicates another species of feline animal, which may be provisionally referred to the type genus. This species was probably about equal in size to *F. serval*; or intermediate between the fourth Siwalik species and *F. subhimalayana*. The antero-posterior diameter of the base of the crown of the canine is 0.32; and the transverse 0.26.

GENUS IV.: MACHLERODUS,³ Kaup.

Synonyms. *Agnotherium*, Kaup (*in parte*). *Cultridens*, Cr. *Drepanodon*, Auct. *Meganthereon*, Auct. *Smilodon*, Lund. *Stenodon*, Cr. *Trueifelis*, Leidy (teste Cope).

Distribution and number of species.—The most important dental and cranial characters of the genus having been already mentioned, it only remains to consider its distribution and the number of species. In time it apparently commenced in the upper eocene and continued down to the pleistocene period: the miocene and (probably eocene) species had smaller canines than those of the later periods.⁴

¹ Busk, "Trans. Zool. Soc. Lon.," vol. X., p. 83.

² Owen, "Odontography," p. 487.

³ The name *Machlerodus* (*Machairodus*) was given by Kaup in 1833 ("Oss. Foss. Mss. d. Darmstadt"), on the assumption that the remains on which it was founded belonged to a reptile. *Stenodon* was published in the same year (E. Geol., "Revue Encyclopéd.", 1833): and *Cultridens* apparently in 1837 (Huot, "Nouveau Cours élémentaire de Géologie," Paris). *Drepanodon* and *Meganthereon*, which are usually cited respectively as Nesti and Croizet, were assigned merely as specific names and have no claim to stand for the genus (*Vide* Gaudry, "An. Foss. et Géol. de l'Alsace," pp. 106, 108). The question of priority lies, therefore, entirely between *Machlerodus* and *Stenodon*; this has, however, been overridden by the universal acceptance of the former.

⁴ The allied, but highly specialized, eocene genus *Evomitus* is apparently a very remarkable exception to this generalization.

In space the genus had a very wide distribution, being found all through America, in a great part of Europe, and northern India.

The following list comprizes the best known species (exclusive of the Indian), with their more important synonymy :—

1. *MACHERODUS CULTRIDENS*¹ (Cuv.) Up. miocene to up. pliocene, Europe.

<i>Agnotherium antiquum</i> , Kaup (<i>in parte</i>).	<i>Machærodus leoninus</i> , Roth. and Wag.
<i>Cultridens arvernensis</i> , Cr.	<i>Megantheron aphanista</i> , Pom.
<i>Drepanodon aphanista</i> , ² Cope.	" <i>cultridens</i> , Pom.
<i>Felis aphanista</i> , Kaup.	<i>Stenodon cultridens</i> , Croiz.
" <i>cultridens</i> , Brav.	<i>Ursus cultridens</i> , Cuv.
" <i>gigantea</i> , Wag.	" <i>arvernensis</i> , Cr. and Job.
<i>Ursus drepanodon</i> , Nestl.	

A large species about the size of the jaguar: $\overline{\text{pm.}} 3$ large, with two fangs: canine stout: descending symphysial expansion comparatively small: anterior lobe of $\overline{\text{pm.}} 4$ with a small talon.

2. *MACHERODUS FATALIS*³ (Leidy). Pliocene, N. America.

<i>Trucifelis fatalis</i> , Leidy.	<i>Smilodon fatalis</i> , Cope.
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A very large imperfectly known species, allied to *M. necator*; the anterior lobe of $\overline{\text{pm.}} 4$ is double.

3. *MACHERODUS GRACILIS* (Cope).⁴ Pliocene, N. America.

Smilodon gracilis, Cope.

A smaller species than the last, only known by the canine, which is remarkable for its great basal compression.

4. *MACHERODUS INSIGNIS*, Filh.⁵ Quercy phosphorites.

A large species only known by fragments of the canine.

5. *MACHERODUS LATIDENS*, Owen.⁶ Pliocene and low. pleistocene, Europe.

<i>Drepanodon latidens</i> , Cope.	<i>Megantheron latidens</i> , Pom.
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A large species, of which the canines, as compared with those of *M. cultridens*, are "thinner or more compressed in proportion to their breadth, especially at the anterior part of the crown, which is sharper."

6. *MACHERODUS MEGANTHEREON*⁷ (Cr. and Job). Pliocene, Europe.

<i>Drepanodon megantheron</i> , Cope.	<i>Megantheron brevidens</i> , Pom.
<i>Felis megantheron</i> , Cr. and Brav.	" <i>macroclis</i> , Pom.
<i>Stenodon megantheron</i> , Cr.	

A species of the size of the leopard, with the dentition of the type of that of *M. cultridens* (of which it is regarded by Gervais⁸ as a smaller race). The descending symphysial expansion is more developed, and extends farther back.

¹ Gaudry, "Animaux Fossiles et Géologie de l'Attique," p. 105. Wagner, 'Abhand. bayer Akad.', vol. VII., pl. IX.

² Regarded by Prof. Cope as distinct: the synonymy here given is that of Prof. Gaudry.

³ Cope, 'Amer. Nat.', vol. XIV., p. 857. ⁴ *Ibid.* ⁵ "Phosphorites du Quercy," p. 152.

⁶ "British Fossil Mammals and Birds," p. 179. Falconer ("Pal. Mem.," vol. II., p. 459) doubted the specific distinctness of this form from *M. cultridens*.

⁷ Gaudry, "Les Enchaînements du Monde Animal—Mam. Tert.," p. 221, fig. 293. Gervais, "Zool. et Pal. Franç.," pl. 27, figs. 1, 2 (*M. cultridens*).

⁸ "Zool. et Pal. Franç.," p. 231.

7. *MACHÆRODUS NECATOR*,¹ Gerv. Pleistocene,² S. America.

Smilodon necator, Cope.

A large species, distinguished by the absence of $\overline{\text{pm. 3}}$, the complex character of the talons of $\overline{\text{pm. 4}}$, and the large descending symphyseal expansion.

 8. *MACHÆRODUS NEOGÆUS*³ (Lund). Pleistocene,
S. America.

Felis smilodon, Blain.

Hyæna neogæa, Lund.

Megatherion neogæus, Pomel.

Smilodon neogæus, Cope.

„ *populator*, Lund.

A species as large as a tiger, distinguished by the huge size of the canines (fig. 17); the large size and complexity of $\overline{\text{pm. 4}}$ and $\overline{\text{pm. 3}}$; the small size and single fang of $\overline{\text{pm. 3}}$; and the comparatively small descending symphyseal expansion: the tubercle of $\overline{\text{pm. 4}}$ is distinct.



Fig. 17. *Machærodus neogæus* (Lund): cranium, much reduced.

 9. *MACHÆRODUS PALMIDENS*⁴ (Blain). Mid. miocene, Europe.

Drepanodon palmidens, Cope.

Felis palmidens, Blain.

Megatherion palmidens, Pom.

A small species, about equal in size to the cheetah (*Cynalurus*); canines small: lower premolars with large fore-and-aft talons.

As doubtful or insufficiently determined species there may be mentioned *M. oggygius* (Kaup)=*Felis oggygia*, Kaup, and *F. antiqua*, Blain, *in parte* (teste Pomel): and *M. maritimus*, Gerv., mentioned by Prof. Cope.⁵ *M. perarmatus*, Gerv.,=*M. bidentatus*, is the same as *Eusmilus*: while *M. brachyops*, Cope, *M. cerebialis*, Cope, *M. occidentalis*, Leidy, *M. primævus*, Leidy, and *M. strigidens*, Cope, constitute the genus *Hoplophoneus*. *M. (Megatherion) hyænoïdes*, Pom., is a *Pseudaelurus*.

Species 1: *MACHÆRODUS SIVALENSIS* (Falc. and Caut.).

Synonyms. *Drepanodon sivalensis*, Falc. and Caut. *Megatherion falconeri*, Pomel.
Machærodus falconeri, Gaudry.

History of Siwalik machærodonts.—Apparently the earliest mention of the occurrence of a species of *Machærodus* in the Siwaliks is in Prof. Owen's "Odontography"⁶ (published from 1840 to 1845), where the fact is simply recorded. The next notice occurs in the "British Fossil Mammals and Birds"⁷ (1846); where some of the teeth are described; but no specific name is assigned. In 1853 Pomel⁸ assigned the name *Megatherion falconeri* to certain remains of a Siwalik *Machærodus*;

¹ Cope, 'Amer. Nat.', vol. XIV., p. 855, figs. 12, 13, 14.

² It appears preferable to class the S. American drift and cavern deposits as pleistocene, rather than with Prof. Cope, as pliocene. The former view is adopted by Prof. J. Le Conte ("Elements of Geology," New York, 1879, p. 544).

³ Blainville, "Ostéographie," Genus Felis, pl. XX.

⁶ P. 491.

⁴ *Ibid.*, pl. XVII.

⁷ Pp. 178-9.

⁵ *Op. cit.*, p. 853.

⁸ "Cat. Meth. Vert. Foss.," etc., p. 56.

⁹ The specimens are stated to be in the collection of the Geological Society of London; but this is probably erroneous.

giving the following characters to the species, viz.:—" *Un peu plus grand que la M. macrocelis* [meganthereon]; *la canine est médiocre*; *la première molaire inférieure sans denticules et petite*; *la dilatation symphysaire très-grande.*" In 1862 Prof. Gaudry¹ mentioned the Siwalik form under the name of *M. falconeri*. In the "Palæontological Memoirs,"² published in 1868, certain remains of the Siwalik *Machærodus* in the British Museum, previously figured in unpublished plate N. of the "F.A.S.,"³ are named *Drepanodon* (*Machærodus*) *sivalensis*, F. and C.: two of the specimens being figured in the first volume⁴; and a note by Dr. Falconer added.⁵ In 1880 Mr. Bose⁶ described the Siwalik machærodonts in the British Museum, and referred them to two species, under the names of *M. sivalensis*, F. and C., and Bose, and *M. pulwandiensis*, Bose: some of the specimens on which the latter was founded having been added to the National Collection after the death of Dr. Falconer, and others having been included in *M. sivalensis*. Later on in the same year the present writer expressed his opinion⁷ that these two species were not distinct; the differences between the remains on which they were founded being due to sex or age. Mr. Bose⁸ subsequently reasserted his own views; which, from being confirmed by specimens recently examined by the present writer, are now adopted.

It will thus be seen that the name *Machærodus falconeri* (Pom.) has the priority over *M. sivalensis*. Since, however, no figures were given with Pomel's notice, which is exceedingly meagre and insufficient, while Falconer's name has met with very general acceptance, it seems better that the latter should be adopted.

Type mandible.—Since the characters of the lower jaw show more clearly than the other remains the distinction between the present and the next species, it will be better in both cases to commence with the description of the mandible. In figures 4, 4a of plate XLIV. there is represented a part of the left ramus of the mandible of a Siwalik *Machærodus* in the British Museum, named *M. sivalensis* in the "F.A.S."⁹; which may be taken as the type specimen. This jaw is the one alluded to by Prof. Owen¹⁰ as indicating a species as large as the jaguar; and shows $\overline{\text{pm. 4}}$, $\overline{\text{m. 1}}$, and the broken base of $\overline{\text{pm. 3}}$, with the commencement of the descending symphysial expansion. The latter commences a short distance in advance of $\overline{\text{pm. 3}}$; and descends very rapidly, with a straight inferior border, indicating that when complete the whole expansion was large. The first tooth ($\overline{\text{pm. 3}}$) is inserted by one fang, and must have been relatively small: $\overline{\text{pm. 4}}$ is remarkable for the height and extreme backward inclination of its crown: it slightly overlaps $\overline{\text{m. 1}}$, and has large fore-and-aft talons; the latter being bicuspid. The carnassial is of the normal type; with a very large posterior lobe.

Second specimen.—In figure 5 of the same plate there is represented a fragment

1 " *Animaux Fossiles et Géologie de l'Attique*," p. 113.

2 Vol. I., p. 550.

3 Preserved in the British Museum, and now reproduced in autotype.

4 Plate XXV., figs. 5 and 6.

5 " *Pal. Mem.*," vol. II., p. 456.

6 " *Quart. Journ. Geol. Soc.*," vol. XXXVI., pp. 122-5.

7 " *Records*," vol. XIV., p. 63.

8 *Ibid.*, p. 266.

9 Plate N., figs. 4, 4a.

10 " *Brit. Foss. Mamm. and Birds*," p. 179.

of the right ramus of a precisely similar mandible, obtained from the Siwaliks of the Rûrki neighbourhood, and now in the Indian Museum.¹ It shows the three cheek-teeth, the summit of the main lobe of $\overline{pm} 4$ being broken off: $\overline{pm} 3$ is very small, inserted by a single fang, and having a sub-conical crown, with a minute hind talon. There is a rudiment of a talon to $m. 1$.

Third specimen.—In figures 8, 8a of plate N. of the "F.A.S." there is represented a fragment of the left ramus of a mandible, with the three cheek-teeth; corresponding in all respects with the last specimen. This jaw is in the Siwalik collection of the British Museum (No. 16,554).

Fourth specimen.—In the accompanying woodcut (fig. 18) there is represented the nearly complete left ramus of the mandible of a Siwalik *Machærodus* in the Dublin Museum.² Posteriorly it is complete, with the exception of the coronoid process; while anteriorly it is broken through the symphysis: it shows part of the alveolus of the canine, and the greater portion of the descending expansion. The three cheek-teeth are preserved; but in a more or less broken condition; a large part of the outer surfaces of $\overline{pm} 4$ and $m. 1$ having been chipped away. These teeth agree with those of the preceding specimens, with the exception that $\overline{pm} 3$, though still small, is inserted by two distinct fangs. The angular process and condyle agree in structure with those of *Felis*. The basal portion of the coronoid process (*cr.*) is extremely short antero-posteriorly, indicating the small size of that process, and that the skull had a prolonged zygomatic process, as in *M. neogaeus* and *M. neotor.* The descending symphyseal expansion commences some distance in advance of $\overline{pm} 3$, and descends very suddenly; its posterior border being straight, and forming an angle of about 45° with the inferior border of the horizontal ramus. When complete this expansion must have been large; indicating the existence of a long upper canine. The diastema appears to have been of medium length.

Compared with the specimen represented in plate XLIV., fig. 4, it will be seen that the posterior border of the descending symphyseal expansion forms a smaller angle with the inferior border of the horizontal ramus; and it seems probable that the whole symphyseal expansion in the former was not produced inferiorly to such an extent as in the Dublin specimen: as, however, the two jaws agree in all other respects there can be little doubt of their belonging to the same species. Since the depth of the symphyseal expansion is generally correlated with the size of the canines, and as it is probable that these were larger in the males than in the females of the same species, it seems highly probable that the Dublin mandible should be

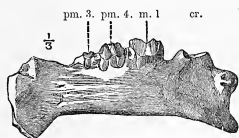


Fig. 18. *Machærodus sivalensis* (Falc. and Caut.). Outer view of left ramus of mandible of a male; from the Siwaliks. Dublin Museum.

¹ Obtained by exchange with the Rûrki Museum.

² One of the specimens purchased from Dr. Beattie (No. 49).

regarded as that of a male, and the British Museum specimen as that of a female. This is confirmed by the larger size of the cheek-teeth in the former.

Comparisons.—In the following table the dimensions of the four specimens described above (taken in the same order) are compared with those of the mandibles of *M. meganthereon* and *M. neogavus*:—

	<i>M. meganthereon.</i>	<i>M. sivalensis.</i>				<i>M. neogavus.</i>
Interval between condyle and canine		5.53 (?)				7.0
Length of diastoma	1.43	1.47 (?)				2.68
Space occupied by cheek-teeth	1.9	2.2	2.2	2.03	2.43	2.73
Depth of jaw in front of pm. 3	1.18	1.35				1.15
" " " at m. 1	1.2	1.18	1.35	1.36	1.41	1.57
Transverse diameter of condyle		1.6				
Length of pm. 3	0.39	0.4 (?)	0.32	0.37	0.44	0.33
" " " 4	0.82	0.85	0.64	0.8	0.94	1.13
Width " " "		0.41				0.53
Length " m. 1	0.71	0.98	1.02	0.9	1.02	1.14

These dimensions indicate that *M. sivalensis* was intermediate in size between the other two species. The carnassial of the smallest specimen is about equal in size to that of a small tiger; but is rather larger in the other specimens, in which the jaw is shorter than in the tiger: the animal was, therefore, probably intermediate in size between the tiger and jaguar, and had relatively large cheek-teeth.

Compared with the species in the list on pages 156-7, the present species in respect of mandibular characters is distinguished from *M. cultrivens* by its inferior size; by the lesser development of the coronoid process and the descending symphyseal expansion; the smaller pm. 3; and the more oblique direction of the lobes of pm. 4. As the mandibles of the species marked Nos. 2, 3, 4, and 5 are unknown, comparisons are impossible. *M. meganthereon* is distinguished by its smaller size; by the larger development of the coronoid process; and by the more backward extension of the descending mandibular expansion, the posterior border of which has not such a sudden separation from the inferior border of the horizontal ramus: pm. 3 apparently agrees in relative size with the corresponding tooth of *M. sivalensis*¹; but the hind talon of pm. 4 is less complex than in the latter. *M. necator* is distinguished by the absence of pm. 3; but the form of the symphyseal expansion, and of the other cheek-teeth appears to be very similar in the two. *M. palmidens* is broadly distinguished by its inferior size, and the complex talons of pm. 3. *M. neogavus*, besides its superior size, differs by the relatively smaller size of its descending symphyseal expansion; but agrees in the proportionate size and structure of the cheek-teeth; pm. 3 being, however, frequently somewhat smaller. The Siwalik jaw agrees with both the S. American species in its small coronoid process.

It appears, therefore, judging from the characters of the mandible, that *M. sivalensis* is distinct from such of the described forms with which it can be compared; but comes nearest in some respects to *M. meganthereon*, and in others to *M. necator* and *M. neogavus*; the characters allying it with the latter being, as will be shown below, of the most importance.

¹ In *M. meganthereon* this tooth is inserted by two fangs; in the Siwalik form it may have either one or two.



Fig. 19. *Machaerodus sivalensis* (Falc. and Caut.). Hinder cheek-teeth: from the Siwaliks. British Museum (No. 39,730). 1.

Maxilla.—In plate XLIV., fig. 2, there is represented from the external aspect the left maxilla of a machaerodont in the Siwalik collection of the British Museum, apparently belonging to the present species.¹ The accompanying woodcut (fig. 19) represents the palatal aspect of the two hinder cheek-teeth of the same specimen. In this maxilla three cheek-teeth are present; viz., pm. 3, pm. 4, and m. 1. The first of these is not fully protruded (indicating the sub-adult age of the animal); and is remarkable for its unusually small size (showing that the specimen cannot belong to a *Felis*); it is inserted by two fangs, and has no distinct talons. The carnassial has a small talon in advance of the first lobe (the summit of which is broken): the three lobes have much the same proportions as in *Felis*; but the whole crown is relatively narrower, and the inner tubercle reduced in size, and not extending so far forward as in that genus.² The form of this tooth indicates that the specimen should be referred to *Machaerodus*. The true molar is a very small tooth with an oval crown. The dimensions of this specimen are as follows, viz.:—

Length of <u>pm. 3</u>	0.45	Antero-posterior diameter of <u>m. 1</u>	0.15
„ „ „ <u>4</u>	1.3	Transverse „ „ „ „	0.27

Since the length of pm. 4 is equal to that of the corresponding tooth of the small tiger's skull referred to above; and since the length of the two first cheek-teeth bears the same proportion to the length of the lower cheek-teeth of *M. sivalensis* as obtains in the corresponding parts of *M. megantheron*, the present specimen may be pretty certainly referred to a small individual of the former species. That species is, therefore, distinguished from all the other forms of which the skull is known, with the exception of *M. megantheron*, by the small size of, and absence of talons to, pm. 3. This is very noteworthy, since in both *M. neogaeus* and *M. necator* the same tooth has distinct fore-and-aft talons. The upper carnassial of the former is distinguished from the Siwalik tooth by the reduplication of its anterior lobe; a similar character also prevailing in *M. fatalis*; but in *M. necator* this tooth has the same structure as in the Siwalik species. The carnassial of *M. megantheron* is also very similar to that of the Siwalik species; its inner tubercle being very small. The minute size of m. 1 in *M. sivalensis* distinguishes it from *M. neogaeus*; in *M. necator*, according to Prof. Cope's figure, this tooth is absent.

Maxilla of a cub.—In figures 1, 1a of plate XLIV. there is represented the right maxilla of a Siwalik *Machaerodus* cub, in the British Museum, showing the milk dentition.³ The teeth present are the broken canine, and the carnassial (mm. 3);

¹ This specimen is also represented in the "F.A.S.," pl. N., figs. 5, 5a; and is described in Mr. Bose's memoir (*op. cit.*, p. 124).

² Mr. Bose states that this tubercle is absent.

³ This specimen is also figured in the "F.A.S.," pl. N., figs. 3, 3a; and, from the palatal aspect, in fig. 5 of the plate accompanying Mr. Bose's memoir.

behind which there is the alveolus of the milk-tubercular (mm. 4).¹ The portion of the canine still remaining is serrated on its posterior edge, and laterally compressed, with the inner surface flat, and the outer convex: when complete it must have been relatively large, and considerably curved. The alveolus of mm. 4 is relatively large, as in the cubs of *Felis*. The milk-carnassial is almost an exact replica in miniature of the permanent carnassial of *M. sivalensis*; with the exception of the almost total disappearance of the internal tubercle. From this fact, and the circumstance that the relative proportions of mm. 3 and pm. 4 in this specimen and the adult maxilla of *M. sivalensis*, are the same as those existing between mm. 3 and pm. 4 in *Felis tigris*, it may be taken as certain that the present specimen belongs to the former species.

Canine.—In figure 6 of plate XLIV. there is represented the lower part of a tooth,² collected by Mr. Theobald in the Siwaliks of the Punjab, which there is every reason to believe is the permanent right upper canine of the present species. The tip of this tooth has been broken off; and the whole crown is so rolled that any serration of its edges that may have existed has disappeared. The crown is laterally compressed, with the inner surface flat, and the outer convex: the anterior border is strongly convex, and the posterior concave. On the latter border there is a well-marked groove, externally to the trenchant edge, which disappears towards the extremity of the tooth. As this tooth is precisely similar in form to the milk-carnassial of *M. sivalensis*, it may be referred to the same species.

In its degree of curvature this tooth is not unlike the upper canine of *M. latidens*,³ but the crown was probably longer. In no species is the inner surface so perfectly flat as in the Siwalik tooth; *M. neogaeus* apparently coming nearest in this respect. The groove on the posterior border seems to be peculiar to the Siwalik tooth. The antero-posterior diameter of the latter at the point of fracture is 0·83, and the transverse 0·5 inch.

Cranium.—In the Indian Museum there is a specimen of the hinder portion of the cranium of a carnivore, collected by Mr. Theobald in the Siwaliks of the Hāshīarpūr district, which from the elongated form of the mastoid process evidently belongs to *Machærodus*; and from its size may probably be referred to the present species. The specimen is so imperfect and so damaged, that it has been considered advisable to figure it only on a reduced scale (fig. 20). The occipital crest is more developed than in any non-Indian species, *M. neogaeus* coming nearest in this respect; the posterior portion of the sagittal crest bending upwards very rapidly. The mastoid process of the petiotic (*m*)⁴ is much produced inferiorly, and indicates the

¹ In his original description ("Brit. Foss. Mamm. and Birds," p. 178) Prof. Owen thought there was the alveolus of a small tooth between the canine and mm. 3. Dr. Falconer and Mr. Bose have, however, shown that this is not the case.

² The section of this tooth exhibits a thick coating of enamel, leaving no doubt as to its mammalian nature.

³ "Brit. Foss. Mamm. and Birds," fig. 69, p. 150.

⁴ In describing the American machærodonts Prof. Cope ('Amer. Nat.' vol. XIV, p. 854) applies the term 'post-tympanic process' to the whole of the bony pedicle situated behind the lower part of the auditory meatus (woodcut, fig. 20, *m*); a comparison of his figures, and of Blainville's plate of *M. neogaeus* ("Ostéographie," *Felis*, pl. XX.), with the skull of the tiger, shows, however, that this part corresponds in the main to the mastoid process of the petiotic, although it is quite probable that a thin post-tympanic process of the squamosal may be applied to its anterior surface. The process will accordingly here be termed the mastoid.

similar production of the zygomatic process of the squamosal,¹ which is but partly preserved. The posterior border of the former process inclines forwards at a large angle with the long axis of the skull. The downward production of the mastoid and zygomatic processes indicates affinity with *M. neogæus*, *M. necator*, and *M. fatalis*, in which the glenoid fossa is situated in the plane of the dental alveoli, instead of far above it as in *Felis*, *M. meganthereon*, and (?) *M. cultridens*. As this arrangement is necessarily correlated with a small coronoid process to the mandible, its existence in the present skull serves to confirm the conclusion as to the specific unity of the latter with the mandibles described above.

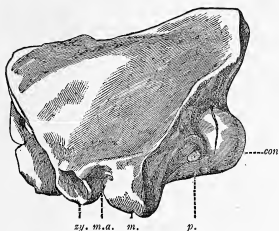


Fig. 20. *Machærodus sivalensis* (Falc. and Caut.). Hinder part of cranium, from the Siwaliks; Indian Museum (No. D. 63): *con*, condyle; *p*, paroccipital process; *m*, mastoid process of petriotic; *sy*, zygomatic process of squamosal, broken inferiorly; *m a*, auditory meatus. $\frac{1}{2}$.

It may be observed that the production of the zygomatic process permits a much wider opening of the mouth, and is, therefore, associated with the largest development of the canines. The presence of this feature in *M. sivalensis* accordingly confirms the inference as to the large size of those teeth in that species.

The posterior border of the mastoid process in the skull under consideration is more nearly vertical than in *M. neogæus* or *M. necator*. In the backward extension of the occiput over the condyles the Siwalik skull agrees with the latter, and differs from the former species (woodcut fig. 17). The upper part of the occipital surface is not unlike that of the tiger, but has rather more lateral expansion superiorly. The width across the condyles is two inches, or nearly the same as in a small tiger's skull; the other parts of the fossil skull being relatively smaller.

Affinities.—Summing up the results of the foregoing comparisons, it appears that *Machærodus sivalensis* is a species coming nearer in its main cranial characters to the American *M. neogæus*, and *M. necator*, than to the European *M. meganthereon*, and (probably) *M. cultridens*. It apparently agrees with the two former in its relatively large canines; while in dental characters it presents a strong general resemblance to *M. necator*, although lacking the suppression of $\overline{pm} 3$; and in the structure of $\overline{pm} 3$ agreeing with *M. meganthereon*. In the small size of $\overline{m.1}$ the Siwalik species again comes nearest to *M. necator*. In the variation in size of $\overline{pm} 3$, and in the tendency to the disappearance of the second fang of this tooth, the species is evidently intermediate between the European and the American forms.

On the whole, *M. sivalensis* must be regarded as decidedly nearest to the American species forming the so-called genus *Smilodon*, but presenting such inter-

¹ Since in some machærodonts the whole glenoidal region of the squamosal is much produced, it will be more convenient to apply to this part the term 'zygomatic' rather than 'post-glenoid' process; which should be strictly confined to the prominence below and behind the glenoid fossa.

mediate dental characters as to leave little doubt of the generic unity of the typical machærodonts.

Distribution.—The present species ranged from the typical Siwalik Hills to the Punjab.

Species 2: *MACHÆRODUS PALÆINDICUS*, Bose.

Syn. *M. sivalensis* (Falc. and Caut.), *in parte*.

History.—The history of this species has been already given under the head of *M. sivalensis*.

Type mandible.—In figure 3 of plate XLIV. there is represented, from the external aspect, the distal extremity of the left ramus of the mandible of the present species; being the specimen in the Siwalik collection of the British Museum on the evidence of which the species was founded.¹ The fragment shows the alveolus of the canine (*c*), behind which there is a comparatively short diastema, followed by the alveolus of $\overline{\text{pm. 3}}$; which was relatively small, and apparently inserted by a conjoint fang: behind this again there is the crown of $\overline{\text{pm. 4}}$, considerably damaged. The jaw is abruptly broken off behind the last-named tooth. The descending symphyseal expansion is unusually large, commencing immediately in advance of $\overline{\text{pm. 4}}$; and its inferior border maintaining a gradual descent as far as the anterior extremity of the specimen, where a bold ridge, descending considerably below the inferior symphyseal border, marks the division between the lateral and anterior faces of the ramus. There is a strongly marked fossa on the outer surface of the symphyseal expansion for the reception of the upper canine, which must have been of large size.

Second specimen.—In figure 4 of the plate accompanying Mr. Bose's memoir there is represented a fragment of the right ramus of the mandible of a feline, which from the relatively large size of the cheek-teeth must be referred to the present genus. The specimen is in the Siwalik collection of the British Museum (No. 48,437), and contains $\overline{\text{pm. 4}}$ and $\overline{\text{m. 1}}$. The length of the former tooth is very nearly the same as in the mandible described above; but the horizontal ramus has a smaller vertical depth; and at the point where the jaw is fractured there is no sign of the commencement of the descending symphyseal expansion, which is well marked at the same point in the type specimen. In all other respects the two jaws agree so closely that they must be referred to the same species; the above-mentioned differences being probably accounted for in the same manner as in the case of *M. sivalensis*; viz., by referring the type specimen to a male, and the present specimen to a female individual: the latter sex being characterized by the smaller extent of the symphyseal expansion of the mandible, and the shorter upper canines.

Third specimen.—In figure 8 of plate XLIII. of the present volume there is represented a fragment of the right ramus of a mandible, precisely similar to the last specimen, containing the bases of $\overline{\text{pm. 3}}$, and $\overline{\text{pm. 4}}$; the latter wanting the summit

¹ The specimen is also represented in figs. 1, 2, 3 of the plate accompanying Mr. Bose's memoir (*op. cit.*). These figures show the internal and anterior aspects.

of its main lobe. There is but a faint indication of the commencement of the symphyseal expansion in front of $\overline{\text{pm. 3}}$; showing the small size of this part.¹ The length of $\overline{\text{pm. 3}}$ is somewhat greater than in the type specimen; but as similar variations obtain in *M. sivalensis*, this character cannot be regarded as of more than individual value. From the precise resemblance of this specimen to the last mandible, it may probably be referred to a female of *M. palvindicus*. The specimen is in the Siwalik collection of the British Museum.

Comparisons.—In the following table the dimensions of the three specimens described above (taken in the same order) are compared with those of the four specimens of the mandible of *M. sivalensis*, and with the mandibles of *M. meganthereon*, *M. cultridens*, and *M. neogæus*, viz.:—

	<i>M. meganthereon.</i>	<i>M. sivalensis.</i>				<i>M. palvindicus.</i>		<i>M. cultridens.</i>	<i>M. neogæus.</i>
Length of diastema	1.43	1.47 (?)				1.27		1.93	2.68
Depth of jaw in front of $\overline{\text{pm. 3}}$	1.18	1.35				1.71		1.65	1.15
„ „ „ at $\overline{\text{m. 1}}$	1.2	1.18	1.35	1.36	1.41	1.2		1.82	1.57
„ „ „ behind canine	1.9	2.4 (?)				2.6		2.2 (?)	2.4
Length of $\overline{\text{pm. 3}}$	0.39	0.4	0.32	0.37	0.44	0.5	0.66	0.8	0.33
„ „ „ 4	0.82	0.85	0.81	0.8	0.94	0.92	0.9	0.92	1.13
Width „ „ „		0.41		0.4		0.49		0.49	0.53
Length „ „ 1	0.75	0.98	1.02	0.9	1.0	1.17 ²			1.14
Antero-posterior diameter of canine	0.4					0.59		0.67	0.8

These dimensions show that *M. palvindicus*, judging from the size of $\overline{\text{m. 1}}$, was fully as large as *M. neogæus*. Taking the two specimens regarded as belonging to the male sex, the mandible of the present species when compared with that of *M. sivalensis* (woodcut fig. 18), is distinguished by the earlier commencement of the descending symphyseal expansion, by the much less distinctly marked angle formed by the junction of the latter with the inferior border of the horizontal ramus, and by the shorter diastema. The inferior termination of the descending expansion is, moreover, rounded in the present species; while in *M. sivalensis* it was evidently pointed, as in *M. necator*. From these differences the symphyseal expansion in *M. palvindicus* is less differentiated from the ramus, giving to the whole jaw a more massive appearance than in *M. sivalensis*.

Comparing the specimens referred to females, there is a much less marked distinction between the mandibles of the two species. Thus while in *M. palvindicus* the symphyseal expansion does not commence till about the same point as in *M. sivalensis*; in the latter (pl. XLIV., fig. 4) the same part is small, with its inferior border forming a gradual junction with the inferior border of the horizontal ramus. The mandibles of the females may, however, be readily distinguished by the larger size of the teeth in *M. palvindicus*, and especially by the greater proportionate width of $\overline{\text{pm. 4}}$. In the same sex $\overline{\text{pm. 3}}$ is generally larger than in *M. sivalensis*.

These comparisons show that the distinctive mandibular characters of these two species are strongly marked only in the male sex, as is the case with some external

¹ The machærodon character of this specimen is indicated by the distinct interval between $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$.

² Given by Mr. Bosc as 1.1.

characters among existing *Felida*.¹ In both sexes *M. palvindicus* must be regarded as a more powerful and larger animal than *M. sivalensis*.

Compared with European and American species the mandible of the male of the present species is distinguished from all, with the exception of *M. meganthercon*, by the earlier commencement of the descending symphyseal expansion: even in that species, however, this expansion has by no means the same vertical extent; while the ridge at the anterior border of the lateral surface is less strongly marked, and more removed from the vertical; and the diastema is relatively longer. The mandible of the skull of *M. neogaeus* figured by De Blainville, which from its large upper canines is certainly that of a male, is distinguished by its longer diastema, smaller symphyseal expansion, and generally more slender form; as well as by the small $\overline{\text{pm. 3}}$. The lower jaw of *M. neogaeus* is like that of *M. sivalensis*. The mandible of the female of *M. palvindicus* is more like that of *M. cultridens*,² but probably had a shorter diastema, and a smaller $\overline{\text{pm. 3}}$. *M. palvindicus* is readily distinguished by its inferior size and the complex character of $\overline{\text{pm. 4}}$.

In respect of the size of $\overline{\text{pm. 3}}$, the present species seems to indicate a form intermediate between the machærodonts of the Old and New Worlds.

Cranium.—In plate N., figs. 1, 1a, 1b, 1c, of the "F.A.S." there are given four views ($\frac{1}{2}$) of the occipital portion of a carnivorous skull from the Siwaliks, in the British Museum (No. 39,728); referred in the description of the plate³ to *M. sivalensis*; but subsequently by Mr. Bose⁴ to his *M. palvindicus*. The specimen is broken off anteriorly in front of the post-orbital process of the frontal by a fracture extending obliquely backwards to the zygomatic process of the squamosal; the portion still remaining is fairly perfect, and as it comprehends the same part as the fragmentary skull of *M. sivalensis* represented in woodcut fig. 20, it is easy to compare the two. In the first place, the present skull considerably exceeds in size that of *M. sivalensis*; the diameter across the occipital condyles being respectively 2.53 and 2.0 inches. The present specimen has a much produced zygomatic process, well preserved on the right side,⁵ bearing a long post-glenoid process; the mastoid process, although broken inferiorly, is also similarly produced, and below the auditory meatus is in contact with the zygomatic process. This proves not only that the specimen belongs to *Machærodontus*, but also to a form allied to *M. sivalensis* and the American species. Irrespective of its superior size, this skull differs from that of *M. sivalensis*, firstly, by the proper occipital surface forming an inverted V, in place of having rounded lateral borders; secondly, by the lateral borders of the occipital crest, when viewed from the side, forming a nearly straight line, in place of bending backwards above the condyles; thirdly, by the posterior border of the mastoid process being set more obliquely to the plane of the occiput; and, fourthly, by the lesser develop-

¹ *E. g.*, *F. leo*.

² The specimen figured by Wagner (*op. cit.*): as all the specimens known (and these are numerous) are similar, it is to be presumed that there was no marked difference in the form of the mandible of the two sexes.

³ "Pal. Mem.," vol. I., p. 550.

⁴ *Op. cit.*, p. 128.

⁵ "F.A.S.," pl. N., fig. 1c.

ment of the occipital crest. The mastoid process is, moreover, antero-posteriorly compressed in the larger, and subcylindrical in the smaller skull. These differences, coupled with the much larger size of the present specimen, leave little doubt as to the specific distinctness of the two crania; and since the present specimen agrees well in proportionate size with the mandible of *M. palaeindicus* its reference to that species by Mr. Bose may be accepted.

Second specimen.—In figure 2 of plate N. of the "F.A.S." there is represented the greater portion of another Siwalik skull in the British Museum (No. 39,729); also referred by Mr. Bose to the present species. The specimen is greatly mutilated and crushed, and lacks the teeth and jaws. From its high occipital crest, and from the position of the condyles being considerably above the level of the auditory meatus, it is pretty certain that the generic reference is correct, while there is a strong probability that the specific one is likewise so. There is apparently some difference in the form of the post-orbital process of the frontal of this and the preceding specimen; but it is quite possible that this may be due to crush, or to differences in age and sex. The present specimen is so damaged that it adds little or nothing to the knowledge of the species.¹

Comparisons.—Compared with European and American species the cranium of *M. palaeindicus* differs from that of *M. megantheron*, and probably, therefore, from that of *M. cultridens*, by the downward prolongation of the mastoid process of the periotic and of the zygomatic process of the squamosal; and thereby agrees with the crania of the American *M. neogæus*, *M. necator*, and *M. fatalis*. In the form of the occipital region the present skull comes nearer to *M. neogæus* than to *M. necator*; the occipital crest of the latter not being raised above the general level of the skull, and the mastoid process running very obliquely, and forming a continuation of the lateral border of the occiput. In *M. neogæus* the occipital crest is more produced, although not to such an extent as in the present species: the supra-occipital, in place of having the shape of an inverted V, being more like an inverted U. A considerable difference may also be observed in the form of the arch covering the auditory meatus. The extreme production of the supra-occipital in the present species probably indicates that the canines were at least as large as in *M. neogæus*;—an inference confirmed by the characters of the mandible. Comparisons are not possible between the present skull and *M. fatalis* and *M. gracilis*.

Upper incisor.—In plate XLIII., fig. 9, there is represented a third left upper incisor of a *Mucharodus*, obtained by Mr. Theobald from the Siwaliks of Asnot, Punjab. The specimen is represented from the inner aspect, and shows the serrated posterior cutting edge; from which the genus is determined. The anterior cutting edge has been entirely worn away; its place being occupied by a large facette (*a*) formed by the attrition of i.3: the opposite surface presents a similar facette formed by the attrition of the lower canine. The form and position of these two facettes determines the tooth to

¹ Mr. Bose draws some conclusions from this specimen as to the relative length of the cranial and facial portions, which seem based on insufficient data.

be the third incisor. The fang of the tooth is unusually large, and considerably bent; the latter character being not improbably due to some lesion of the jaw of the animal to which it belonged. From the very large size of the specimen it may be pretty safely referred to the present species.

The specimen is of some importance, as it readily distinguishes *M. palvindicus* from *M. latidens*; in which the corresponding tooth¹ has distinct cusps at the base of the inner sides of the fore-and-aft trenchant ridges, which are totally wanting in the Siwalik tooth.

Affinities.—The foregoing comparisons indicate the distinctness of the present form from any sufficiently described species; and also that it was more nearly allied to the other Siwalik species and the American forms than to any of the European species, although in the structure of the mandible and $\overline{\text{pm.3}}$ it presents certain indications of affinity with the latter; thus confirming the conclusions previously arrived at, as to the inadvisability of generically separating the American and European forms.

The relationship of the Indian and American machærodonts is a very remarkable one; and the more so since several genera of Siwalik carnivores (*e.g.* *Hyæna* and *Mellivora*) are essentially Old World forms. This relationship probably indicates a line of passage for the Siwalik and American forms through the regions to the westward of China.

Distribution.—Remains of the present species have been obtained from the typical Siwalik Hills to the Punjab.

LIMB-BONES OF FELINES.

General.—It has been already observed that in the reference of the fossil limb-bones of the *Felidae* to their respective species, relative size is in the main the only guide; and since in the case of the Siwalik representatives of the family there is frequently more than one species of the same approximate size, this guide is little better than useless. It has, therefore, been found advisable only to describe some of the more perfect of these remains, taking them in their serial order; and making suggestions as to the species to which they may possibly belong.

Humerus.—In figure 11 of plate XLIV. there is represented the anterior surface of the distal extremity of the right humerus of a large feline in the Siwalik collection of the British Museum (No. 37,146); in which there is another very similar specimen (No. 37,142), broken off at the supra-condylar foramen (*c.f.*). The dimensions of these two specimens are compared with those of a humerus of the cave-lion, from Clacton (B. M., No. 28,014); *viz.* :—

	Cave-lion.	Siwalik feline.	
		37,146.	37,142.
Width across condyles	3.8	3.6	3.9
„ „ articular surfaces	2.78	2.35	2.75
„ of shaft above supra-condylar foramen	2.3	2.1	

¹ "Brit. Foss. Mamm. and Birds," fig. 70, p. 182.

The Clacton bone is intermediate in size between the humerus of an average existing lion and that of the largest cave-lion; thus indicating the relative size of the animal to which the Siwalik bone belonged. The supinator ridge (*s. r.*) is rather more strongly marked in the latter, and the internal condyle (*i. c.*) is longer, but there is no other very prominent mark of distinction between the Siwalik and Clacton bones. The supra-condylar foramen (*c. f.*) is considerably smaller than in the tiger; but its anterior aperture is relatively large, as in the lion and jaguar.

The form of this bone indicates that it belonged to a species distinct both from the fossil and recent lions, and the tiger; while its large size shows that the only known Siwalik felines to which it could have belonged are *Felis cristata* or *Macharodus paleindicus*. Since in the humerus of *M. neotor*, to which the latter species is allied, there is no supra-condylar foramen,¹ it is not improbable that the same condition may have obtained in the Indian species, and there is accordingly more likelihood that the bone under consideration belonged to *F. cristata*: this is confirmed by its general similarity to the humerus of the lion, and by the fact that in *M. megalanthercon*² although the supra-condylar foramen is present, the lateral expansion of the internal condyle of the humerus is very slight.

Ulna.—In figure 1 of plate XLV. there is represented, from the external (preaxial) aspect, the proximal extremity of the right ulna of a large feline from the Narbada beds.³ This specimen agrees in proportionate size with the humerus described above; and although of larger size than in an existing lion, agrees very closely with the ulna of that animal; especially in the inward inclination and pyriform shape of the olecranal tuberosity (*left side of top of figure*), in the narrowness of the groove separating the two small tuberosities on the superior surface, and in the form and proportion of the two sigmoid cavities. In the tiger the olecranal tuberosity is more elongated and less prominent, the small tuberosities on the superior surface are less developed and more widely separated, and there is a prominent ridge on the posterior surface, which is wanting in the present specimen and the ulna of the lion. The species of cats that existed in the Narbada period are at present unknown, but it is highly probable that *Macharodus* had disappeared. The present bone may quite possibly have belonged either to *F. cristata* or *F. leo*, if either existed in the Narbada period.

In the Indian Museum there is the proximal extremity of the right ulna of a somewhat smaller feline (No. D. 74), from the Siwaliks of the Punjab: this specimen, though too damaged for figuring, has a relatively shorter olecranal process, and probably belongs to a distinct species from the last specimen.

Femur.—In figure 2 of plate XLV. there is represented the distal half of the

¹ 'Amer. Nat.,' vol. XIV., p. 854, fig. 15 ('epitrochlear canal').

² Blainville, "Ostéographie," Genus *Felis*, pl. XVIII.

³ This specimen was in the old collection of the Geological Survey of India, previous to its removal to the Indian Museum, among other Narbada specimens. From its mineralogical condition the present writer was formerly disinclined to admit its Narbada origin ('*Journ. As. Soc. Beng.*,' vol. XLIX., pt. 11, p. 27); but as other specimens exhibit a precisely similar condition this may be admitted.

right femur of a large feline, collected by Mr. Theobald in the Siwaliks of the Punjab. This bone is relatively somewhat smaller than the humerus and ulna described above, and indicates an animal about equal in size to a rather small tiger. It is readily distinguished from the femur of the lion, by the nearly cylindrical form of the middle of the shaft; and in this respect is more like the femur of the tiger, although the lower part of the anterior surface is more flattened. On the posterior surface the intercondylar notch is relatively wider than in the tiger, and more like the same part in the lion; the inner border of the external condyle is also placed more obliquely than in the tiger, in nearly the same manner as in the lion. The trochlear surface for the patella is narrower and deeper than in the lion, and more like that of the tiger. It is not improbable that this bone may have belonged to the smaller species of *Machærodus*.

In the British Museum there are ten specimens of the distal extremity of the femur of large felines from the Siwaliks, and one from the Narbadas. The dimensions of the largest specimen of the former (No. 40,527) are compared below with those of a femur of the cave-lion in the same collection (No. M. 270), and of a large African lion; *viz.*:

	Cave-lion.	African lion.	Siwalik sp.
Width across condyles	3·5	2·0	2·9
„ „ trochlea for patella	1·88	1·4	1·4
Transverse diameter of shaft above condyles	2·4	1·95	1·95
Antero-posterior „ „ „ „	1·7	1·5	1·4

In the Siwalik bone the anterior surface above the condyles is more angulated, and less flattened than in the lion, or in the smaller Siwalik femur described above. From its large size it is probable that the present specimen belonged either to *F. cristata*, or *M. palæindicus*.

Patella.—The patella represented in pl. XLV., fig. 4, was obtained by Mr. Theobald in the Siwaliks of the Punjab; and indicates a feline nearly as large as the cave-lion. In its elongated form this bone is more like the patella of the lion than that of the tiger; but its posterior surface is more convex than in either; the patella of the tiger coming nearest in this respect. This bone not improbably belonged either to *F. cristata* or *M. palæindicus*.

Calcaneum.—The two calcanea represented in pl. XLV., figs. 6 and 7, were obtained by Mr. Theobald from the Siwaliks of the Punjab. The former, belonging to the right side, agrees almost exactly in form and size with the corresponding bone of *F. pardus*; and may have belonged to the same species as the mandible represented in pl. XLIII., fig. 4. The latter, belonging to the left side, is of nearly the same size as the calcaneum of the lynx; and may possibly have belonged to the species of which the mandible is represented in pl. XLIII., fig. 7; or to one of the genera of primitive cats.

Scapho-lunar.—From the pleistocene Jamna beds of the Bánda district Mr. J. Cockburn¹ has obtained a nearly perfect specimen of a right scapho-lunar, indis-

¹ See "Records," vol. XV., p. 33.

tinguishable from the corresponding bone of *F. tigris*. It is quite possible that this species may have existed in the pleistocene; but it requires further evidence before this point can be determined.

Phalangeals.—A proximal phalangeal bone of a feline as large as the tiger, from the Siwaliks of the Punjab, is represented in pl. XLIII, fig. 10. This specimen, with others in the Indian Museum, may have belonged either to *F. cristata*, or *M. palawindicus*.

Other remains.—There are several specimens of the astragali of Siwalik felines in the British Museum, and a few other fragments of limb-bones in the Indian Museum; but nothing would be gained by their description, the specimens noticed above having fully confirmed the inferences drawn from the teeth and jaws as to the existence of an extensive feline Siwalik fauna; and having proved the existence of at least one large-sized member of the group in the Narbada period.

FAMILY VI. HYÆNODONTIDÆ.

Extent and affinities.—The present family is taken to include *Hyænodon*, *Pterodon*, *Oxyæna*, and not improbably *Cynhyænodon*, with perhaps some other genera from the older American tertiaries. By Prof. Cope¹ *Pterodon* and *Oxyæna*, constituting with *Protopsalis* the family *Oxyænidae*, are, with other families, referred to a distinct order, under the name of Creodonta. On account of its alleged larger brain, *Hyænodon* is, however, referred by the same writer² to the Carnivora. By all other palæontologists *Hyænodon* and *Pterodon* are considered as closely allied forms, probably belonging to the same family; and this view is adopted here. It has been thought by some writers that these genera were allied to the marsupials, but the observations of Dr. Filhol³ have shown this view to be erroneous. By Prof. Huxley⁴ it is considered probable that they occupy a position connecting the Carnivora with the Insectivora; and on this view the family is provisionally included here in the former order.⁵ One of the most distinctive points of the family is the small size of the brain, which in *Cynhyænodon* is more like that of an insectivore than a carnivore; while another is the structure of the last three cheek-teeth, all of which assume a sectorial character.

GENUS: HYÆNODON, Laizier and Pariere.

Synonym, *Taxotherium*, Blain.

Distribution, etc.—This genus has been hitherto recorded only from Europe and N. America; in the former area making its appearance in the upper eocene

¹ 'Pro. Amer. Phil. Soc.,' 1880, p. 76: 1881, p. 156.

² "Rep. U. S. Geog. Surv. W. of 100th Meridian," vol. IV., pt. II., p. 89.

³ "Phosphorites du Quercy," p. 169.

⁴ 'Pro. Zool. Soc.,' 1880, p. 284.

⁵ It will be understood that although this family is placed next the *Felidae*, this does not imply any connection between the two. The affinities of the *Hyænodontidæ* are more probably with the lowest viverron-canoids. The family and its allies not improbably renders it impossible to distinguish the Carnivora from the Insectivora.

(oligocene) of Hampshire¹ and the Paris basin,² and surviving till the lower miocene. A considerable number of species have been recorded; but as there are only two of these approaching in size to the Indian form, it will be unnecessary to give a list.

Species: *HYÆNODON INDICUS*, n. sp., *nobis*.

History.—The present species is mentioned here for the first time.

Last lower premolar.—The tooth represented in the accompanying woodcut (fig. 21) was obtained by Messrs. Garnett and Trotter from the Siwaliks of Kúshalghar, below Attock.³ As the specimen is implanted in a fragment of the mandible, there is no doubt as to the series to which it belongs. The crown is sub-conical; highly convex on the outer, and flattened on the inner side: posteriorly it has a large talon, of a triangular form, while there is a much smaller anterior talon: the fore-and-aft edges are sub-



Fig. 21. *Hyænodon indicus*, *nobis*, 4th right lower premolar: from the Siwaliks of Kúshalghar; Indian Museum (No. D. 57): *a* from the outer, *b* from the inner aspect. $\frac{1}{2}$.

trenchant; and there is a small secondary cusp on the latter, near the summit of the crown. This tooth agrees so essentially with $\overline{\text{pm. 4}}$ of *Hyænodon*, that there is every probability of its belonging to that genus: and in any case it must have belonged to a closely allied form.

The only described species having teeth as large as the present specimen is the American *H. horridus*, Leidy⁴; but the anterior talon is absent in $\overline{\text{pm. 4}}$ of that form. In the somewhat smaller *H. heberti*, Filh.,⁵ from Quercy, $\overline{\text{pm. 4}}$ is exceedingly like the present specimen; but the two talons are perhaps more nearly equal in size. In the still smaller *H. requieni*, Gerv., the same tooth is also very similar to the present specimen, but the relative convexity of the outer, and the flatness of the inner surface, is less marked in the former. In *H. leptorhynchus*,⁶ L. and P., there is no distinct anterior talon to $\overline{\text{pm. 4}}$. Since all the other species are of smaller size, there can be no doubt of the specific distinctness of the Indian form; which may receive the specific name *indicus*.

Third lower true molar.—The tooth represented in pl. XLIII., fig. 5, obtained by Mr. Theobald from the Siwaliks of the Punjab, is apparently the 3rd left lower true molar of an animal of the present group. It is divided into two distinct lobes, of which the first is the stoutest: externally there is a stout cingulum forming the base

¹ Lower Haddon: vide 'Quart. Journ. Geol. Soc.,' vol. XXXIX., p. 571: this statement is founded on a mandible in the British Museum (No. 29,752).

² 6th *etage* of Prof. Gaudry.

³ Vide "Pal. Mem.," vol. I., p. 414: this specimen is not mentioned by Dr. Falconer, although it was in the collection submitted to him by Dr. Oldham.

⁴ "Extinct Mammalian Fauna of Dakota and Nebraska," pl. III.

⁵ "Phosphorites du Quercy," figs. 158-60.

⁶ *Ibid.*, fig. 143: Blainville, "Ostéographie," Genus *Subursus*, pl. XVII.

of the crown. Posteriorly the lower border of the enamel of the crown runs suddenly upwards on both sides, nearly to the summit of the hind lobe. The tooth has been considerably worn; the plane of detrition being very oblique, and the longitudinal diameter of the worn surface of the hind lobe running nearly horizontally: it was implanted in the jaw by two fangs of nearly equal size, diverging widely from the middle of the crown. In figure 6 of the same plate there is represented the hinder lobe of a less worn specimen of the corresponding tooth of the opposite side¹; also from the Siwaliks of the Punjab. This specimen shows the same upward flexure of the inferior border of the enamel at the posterior extremity; as well as a similar height of the summit of the hinder lobe above the same.

The only tooth with which these specimens appear to correspond is the last lower true molar of *Hyenodon*²; in some species of which (e.g., *H. heberti*,³ *H. leptorhynchus*⁴) the lower border of the enamel bends upwards at the posterior extremity of the tooth in precisely the same manner, although not quite to the same extent, as in the Siwalik teeth. In none of the European or American species, however, is there the marked cingulum of the latter; while in all the larger forms the hinder lobe is relatively longer; although in the much smaller *H. crucians*, Leidy,⁵ the two lobes are more nearly of the same length. In all, the anterior lobe is much stouter than the posterior; and the wear of the summits of the lobes is similar to that of the Indian teeth.

In relative size the teeth under consideration accord sufficiently well with the lower premolar of *H. indicus* to have belonged to the same species; and it appears highly probable that such may have been the case. If this association be correct, the presence of the cingulum in $\overline{m.3}$ of the Indian form, in view of the close resemblance existing between $\overline{pm.4}$ of the latter and the corresponding tooth of the European and American species, need not of itself indicate more than specific distinction. It is, however, possible that subsequent finds may indicate either that the true molars belong to a distinct species, or even genus, from the premolar; or that, although belonging to the same species, the Indian teeth are generically distinct from, although closely allied to, *Hyenodon*.⁶ In the absence of further evidence it is preferable to refer them provisionally to the same species, and to the type genus.

Whichever of the above-mentioned views be correct, the occurrence in the Siwaliks of a *Hyenodon*, or a closely allied form, is a matter of extreme interest. From the extreme rarity of its remains it is not impossible that the Indian form was on the point of extinction in the Siwalik epoch.

¹ This specimen is not figured in quite the same position as the corresponding part of the more perfect tooth: the fang should have inclined towards the left.

² These teeth might at first sight be taken for the lower carnassials of a feline; but are at once distinguished by the form of the lower border of the enamel and of the worn surfaces of the summits of the lobes; by the presence of the cingulum, and the size and direction of the fangs.

³ "Phosphorites du Quercy," fig. 153.

⁴ Blainville, *op. cit.*

⁵ *Op. cit.*, pl. II.

⁶ Neither of the teeth present any close resemblance to *Pterodon* or *Oxyena*: the other American genera are at present insufficiently described.

ADDENDUM.

Mandible of Lutra sivalensis.—Since the description of *Lutra sivalensis* was printed a fragmentary specimen of the mandible of that species, represented in plate XLV., figs. 3, 3a, has come under the writer's notice. This specimen is in the Ipswich Museum, to which it was presented, with some other Siwalik fossils, by Miss Cautley; having doubtless been obtained by Sir P. T. Cautley. It comprizes the hinder portion of the right ramus, and shows the root of $\overline{m.2}$, and the carnassial ($\overline{m.1}$), of which the anterior half is broken: the condyle, angle, and the summit of the coronoid process are likewise wanting. The shape of $\overline{m.1}$, the mode of implantation of $\overline{m.2}$ (which is set close into the anterior border of the ascending ramus, and very obliquely to the alveolar line of the other cheek-teeth), and the form of the masseteric fossa (characterized by its great depth and the regular curve of its anterior border) show that the specimen belongs to an otter; while the large size of the specimen indicates that it should be referred to *Lutra sivalensis*. The last true molar ($\overline{m.2}$) is implanted by a single fang, as in all living otters. The carnassial has been partially worn: its talon has precisely the same structure as in other otters, but its central depression is slightly less deep: the bases of the hinder cusps of the blade which still remain, show that these also occupied the same relative position. The depth of the jaw, as in *Lutra bathygnathus*, exceeds the length of the carnassial, indicating, in conjunction with the great depth of the masseteric fossa, the enormous biting power of the animal. In all other respects the specimen agrees with the jaws of living species of otter. The length of the carnassial is 0·84, and the depth of the jaw below this tooth 1·25 inches.

This unique specimen confirms the conclusions previously arrived at as to the generic identity of the gigantic Siwalik otter with *Lutra*; and also as to the specific distinctness of *L. bathygnathus*.

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¹ The abbreviations are in general the same as those employed in the "Geological Record." Neither this nor the preceding lists are intended as complete bibliographies.

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PLATE I.

ACEROTHERIUM PERIMENSE, Falconer and Cautley.

Cranium of an adult, viewed from the left side (fig. 1), and from the front (fig. 2): from the Punjab. One-third natural size. (No. C. 1, Ind. Mus.)



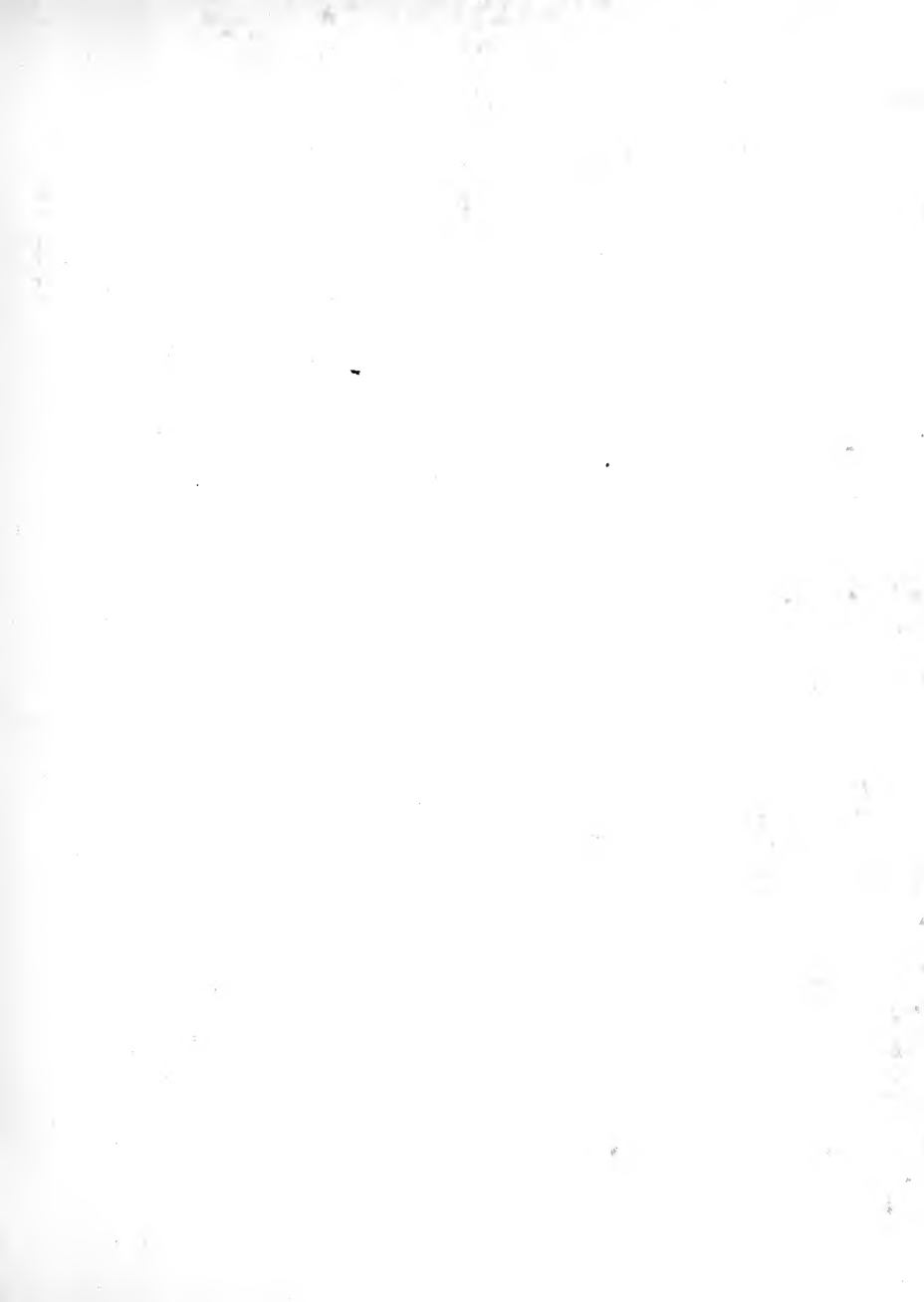
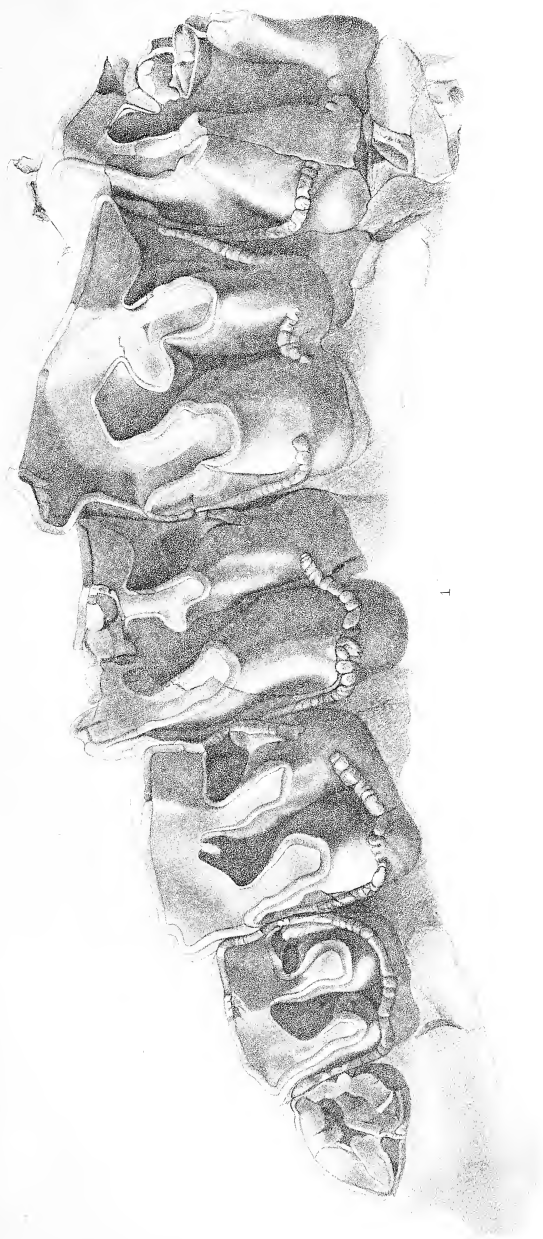


PLATE II.

ACEROTHERIUM PERIMENSE, Falconer and Cautley.

A portion of the left upper molar series, showing the four premolars, and the first, and part of the second true molar : from the Punjab : natural size, and viewed from the inner side. (No. C. 2, Ind. Mus.)



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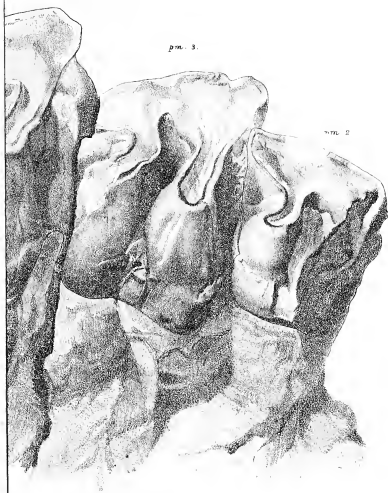


PLATE II A.

ACEROTHERIUM PERIMENSE, Falconer and Cautley.

The right upper molar series, from a palate specimen in the Museum of the Bombay Branch of the Royal Asiatic Society : from Perim Island : natural size, and viewed from the inner side.

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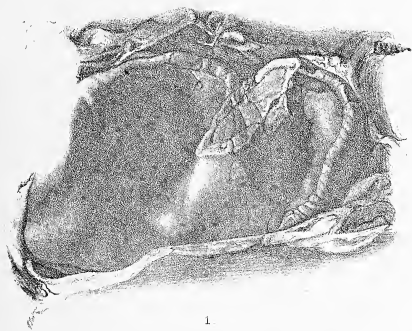


PLATE III.

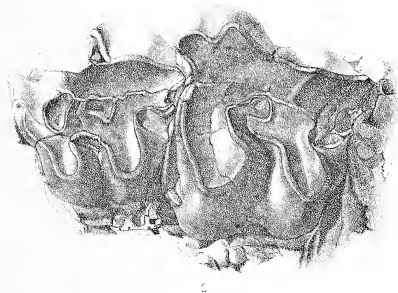
ACEROTHERIUM PERIMENSE, Falconer and Cautley.

- Fig. 1. Part of the left ramus of a young mandible, showing the first true molar in its alveolus.
(No. C. 238, Ind. Mus.)
- „ 2. Second and third left upper milk-molars. (No. C. 18, Ind. Mus.)
- „ 3. Second right upper true molar. (No. C. 7, Ind. Mus.)
- „ 4. Left upper incisor, viewed from the inner side; the inferior border on the left.
(No. C. 14, Ind. Mus.)
- „ 5. Third right upper true molar (No. C. 3, Ind. Mus.)

All the specimens are drawn of the natural size, and were obtained from the Siwaliks of the Punjab.



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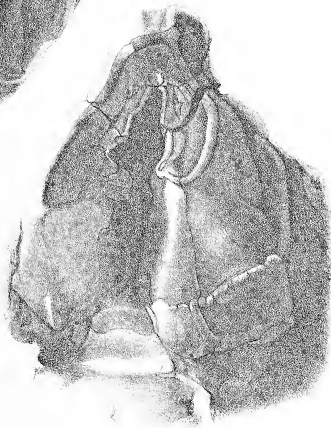
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PLATE IV.

ACEROTHERIUM PERIMENSE, Falconer and Cautley.

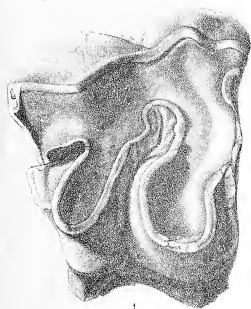
- Fig. 1. The symphysis and part of the right ramus of the mandible, showing incisor, premolars and first true molar, viewed from the outer side.
- „ 2. The first and second true molars of the opposite side of the same mandible, viewed from the outer side: from the Punjab. Both figures are of the natural size. (No. C. 4, Ind. Mus.)



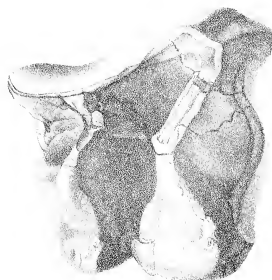
PLATE V.

RHINOCEROS SIVALENSIS, Falconer and Cautley.

- Fig. 1. Second right upper true molar : half worn : from the Punjab. (No. C. 23, Ind. Mus.)
„ 2. Second right upper true molar : slightly touched by wear : from the lower Manchhar group of Sind. (No. C. 34, Ind. Mus.)
„ 3. Second left upper premolar : much worn : from the Punjab. (No. C. 77, Ind. Mus.)
„ 4. Last left upper true molar : in an intermediate state of wear : from the Punjab. (No. C. 11, Ind. Mus.)
„ 5. First, or second, left upper true molar : in germ : from the Punjab. (No. C. 37, Ind. Mus.)
„ 6. Third right upper premolar : one-third worn : from the Punjab (No. C. 26, Ind. Mus.)
„ 7. Var. GAJENSIS. First, or second, right upper true molar : partly broken : from the Gáj group of Sind. (No. C. 38, Ind. Mus.)



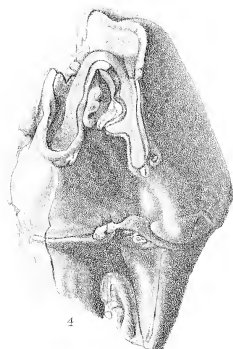
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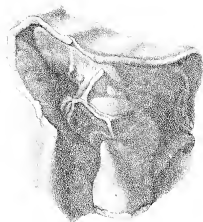
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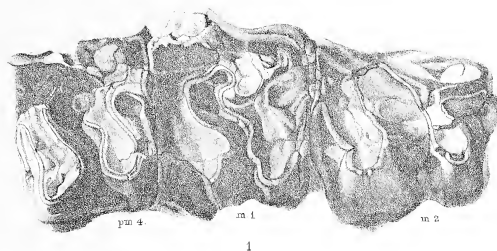
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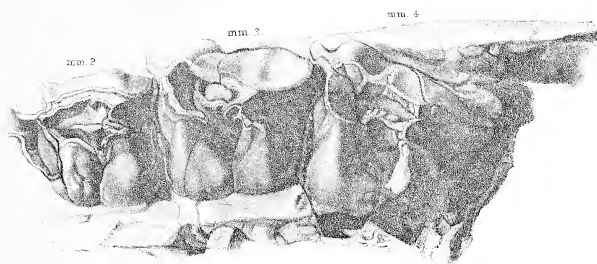
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PLATE VI.

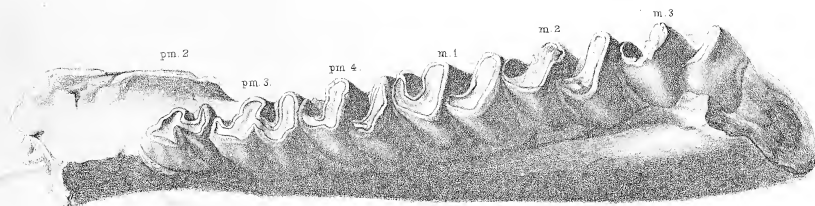
- Fig. 1. RHINOCEROS PALENDICUS (?) Falc. and Caut.: last premolar, and first and second true molars: from the Punjab: natural size. The specimens belong to a small form of the species. (No. C. 50, Ind. Mus.)
- „ 2. RHINOCEROS SIVALENSIS (?) Falc. and Caut.: second, third, and fourth milk-molars of the left side: from the Punjab: natural size. (No. C. 46, Ind. Mus.)
- „ 3. RHINOCEROS SIVALENSIS (?) Falc. and Caut. Symphysis and left ramus of mandible, containing second, third, and fourth premolars, and three true molars: from the Punjab: half natural size. (No. C. 56, Ind. Mus.)



1



2



3.



PLATE VII.

- Fig. 1. RHINOCEROS SIVALENSIS, Falc. and Caut., var. GAJENSIS Lyd. Hinder part of cranium :
from the Gáj group of Sind. (No. C. 36, Ind. Mus.)
- „ 2. RHINOCEROS PALEINDICUS (?) Falc. and Caut. Last right upper premolar : from the
Punjab. (No. C. 26, Ind. Mus.)
- „ 3. RHINOCEROS PALEINDICUS, Falc. and Caut. The four milk-molars of the right side ;
from the cast of a young skull in the British Museum, from the Siwaliks.
- „ 4. RHINOCEROS PLATYRRHINUS, Falc. and Caut. Second and third left upper milk-molars ;
from the cast of a specimen in the British Museum, from the Siwaliks. (No. C 47,
Ind. Mus.)

Fig. 1 is drawn of about half the natural size, the rest are drawn of the natural size.





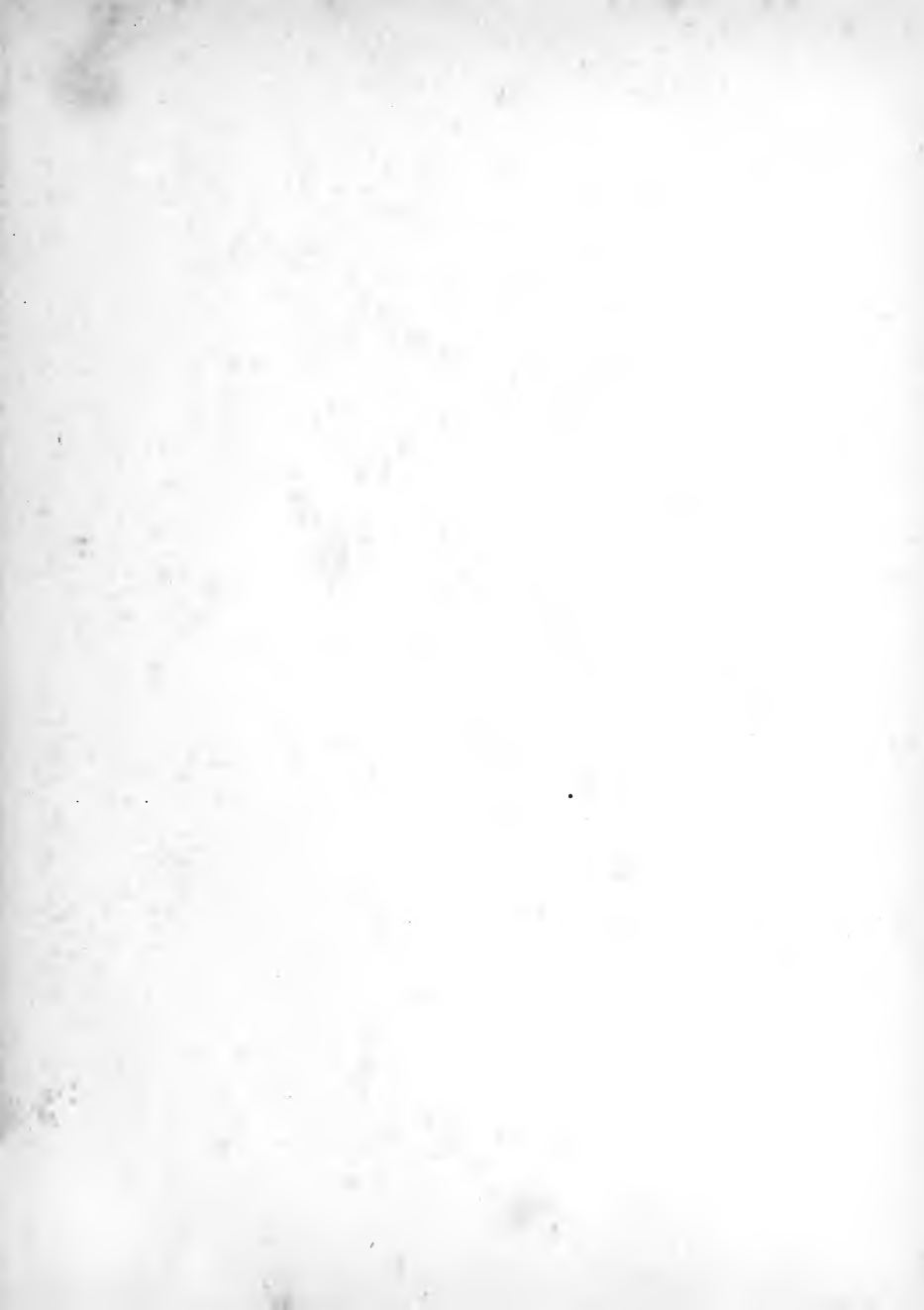


PLATE VIII.

RHINOCEOS PLATYRHINUS, Falconer and Cautley.

The right upper molar dentition : from the cast of a cranium in the British Museum, collected by the late Colonel Baker in the Siwaliks : two-thirds the natural size.

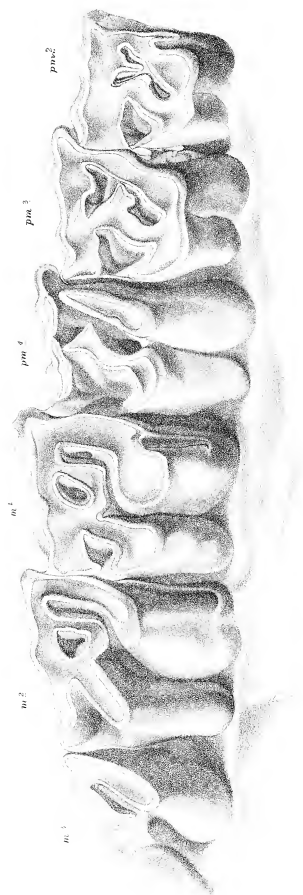




PLATE IX.

- Fig. 1. ACEROTHERIUM PERIMENSE, Falc. and Caut. Siwalik: restored view of cranium, from the specimen figured in plate I: the relations of the inferior squamosal processes, and the presence of two incisors are hypothetical. About one-sixth natural size.
- „ 2. RHINOCEROS PLATYRHINUS, Falc. and Caut. Siwalik: restored view of cranium, from a cast of the specimen collected by Colonel Baker in the Siwaliks, and now in the British Museum: the union of the inferior squamosal processes is not clearly exhibited. About one-sixth natural size.
- „ 3. RHINOCEROS SUMATRENSIS, Cuv. Recent: lateral view of cranium, copied from De Blainville's "Ostéographie." Rhinoceros, plate II: the non-union of the inferior squamosal processes is well shown. One-fifth natural size.

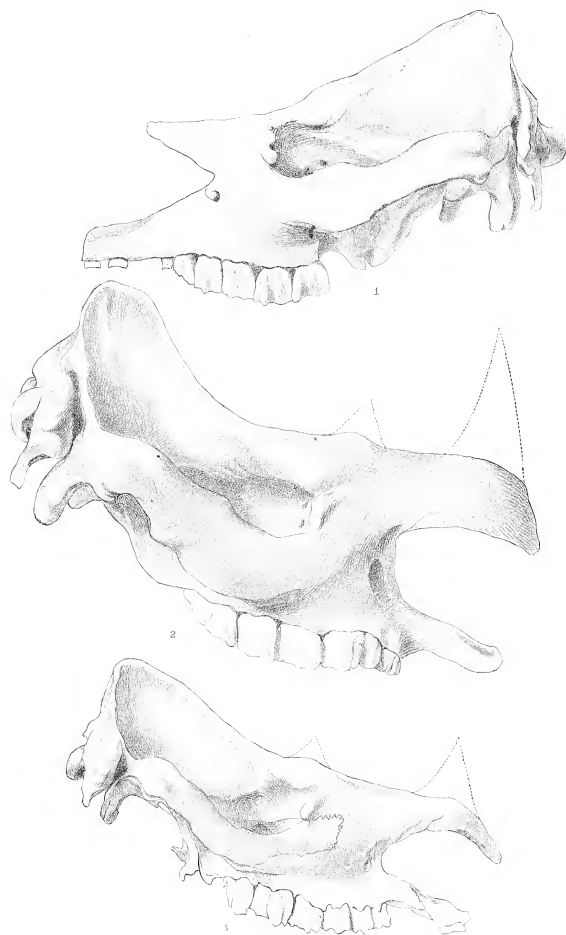




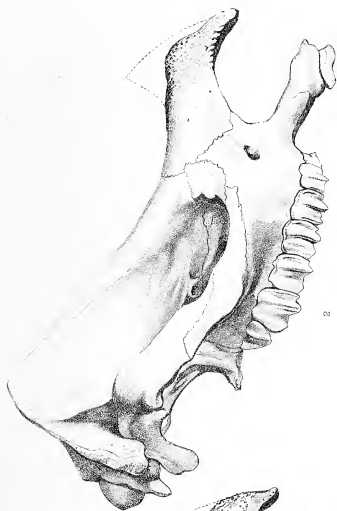
PLATE X.

- Fig. 1. RHINOCEROS INDICUS, Cuv. Recent: lateral view of adult cranium copied from De Blainville's "Ostéographie." Rhinoceros, plate II: one-fifth natural size.
- „ 2. RHINOCEROS JAVANICUS, F. Cuv. Recent: lateral view of cranium copied from De Blainville, *loc. cit.*: one-fifth natural size.
- „ 3. RHINOCEROS PALÆINDICUS, Falc. and Caut. Siwalik: restored and reduced view of cranium taken from specimen drawn in plate LXXIII, fig. 1a, of the "Fauna Antiqua Sivalensis." About one-sixth natural size.
- „ 4. RHINOCEROS SIVALENSIS, Falc. and Caut. Siwalik: restored view of a specimen in the Indian Museum, collected by Mr. Theobald in the Siwaliks of the Punjab. About one-sixth natural size.

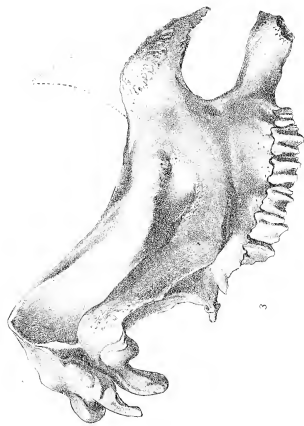
TERTIARY VERTEBRATA



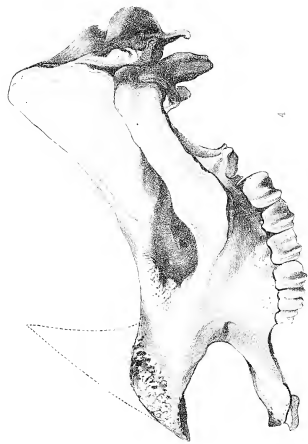
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PLATE XI.

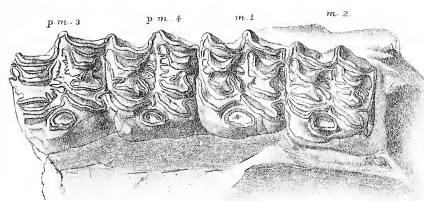
- Fig. 1. *HIPPOTHERIUM ANTILOPINUM*. Falc. and Caut.; part of left maxilla, showing premolars 3 and 4 (pm. 3, pm. 4), and true molars 1 and 2 (m. 1 and m. 2), from a specimen collected by Mr. Theobald in the Siwaliks of Niki, in the Punjab (No. C. 139, Ind. Mus.). The teeth are in an early stage of wear, but later than in figure 3.
- Fig. 2. *HIPPOTHERIUM ANTILOPINUM*. Falc. and Caut; the milk-molar dentition of the left side, of a colt about one year old; from a palate specimen collected by Mr. Theobald in the Siwaliks of Niki. The specimen shows the four milk-molars (mm. 1 to mm. 4), and the unworn germ of the first true molar (m. 1), (No. C. 138, Ind. Mus.). The teeth are in an early stage of wear.
- Fig. 3. *HIPPOTHERIUM THEOBALDI*. Lydekker. Fragment of the left side of the maxilla showing the two last premolars (pm. 3, pm. 4), and the two first true molars. Collected by Mr. Theobald in the Siwaliks of Niki (No. C. 151, Ind. Mus.). The teeth are in a very early stage of wear.
- Fig. 4. *HIPPOTHERIUM THEOBALDI*. Lydekker. Fragment of the left maxilla of a colt, about one year old, showing the three last milk-molars (mm. 2, mm. 3, mm. 4), and the broken base of the first tooth of the same series (mm. 1). Collected by Mr. Theobald in the Siwaliks of Kaipar, in the Punjab (No. C. 153, Ind. Mus.). The teeth have only just come into wear.

All the specimens are represented of the natural size.

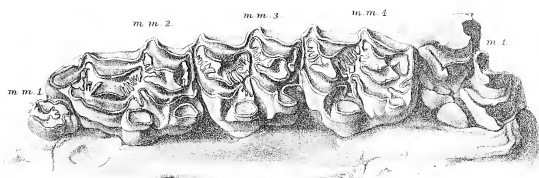
TERTIARY VERTEBRATA.

Geol. Surv. of India.

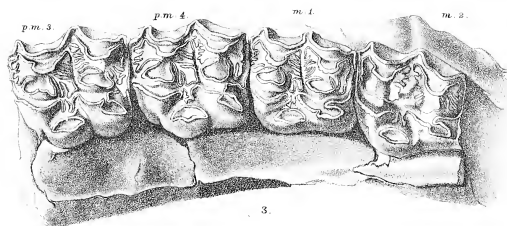
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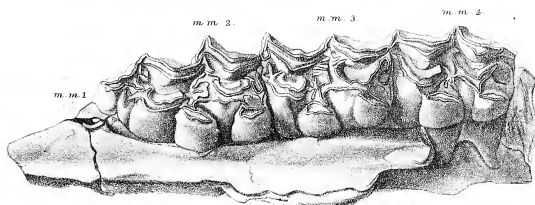
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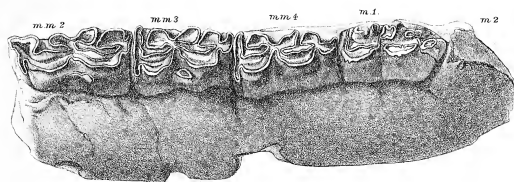
PLATE XII.

- Fig. 1. *HIPPOTHERIUM ANTILOPINUM* (?) Falc. and Caut. Fragment of the left ramus of the mandible of a colt, showing the three last milk-molars (mm. 2, mm. 3, mm. 4), the first true molar (m. 1), and the alveolus of the second (m. 2). Collected by Mr. Theobald in the Siwaliks of the Punjab (No. C. 148, Ind. Mus.).
- Fig. 2. *HIPPOTHERIUM THEOBALDI*. Lydekker. The greater part of the left ramus of the mandible, wanting a small portion in the middle, and showing the second and third premolars (pm. 2, pm. 3), and the three true molars (m. 1, m. 2, m. 3). Collected by Mr. Theobald in the Siwaliks of Niki, in the Punjab, associated with the specimen drawn in figure 3 of plate xi. (No. C. 159, Ind. Mus.).
- Fig. 3. *HIPPOTHERIUM ANTILOPINUM* (?) Falc. and Caut. Part of left ramus of the mandible, containing the third and fourth premolars (pm. 3, pm. 4), and the three true molars (m. 1, m. 2, m. 3). Collected by Mr. Theobald in the Siwaliks of the Punjab. (No. C. 142, Ind. Mus.).
- Fig. 4. *HIPPOTHERIUM THEOBALDI*. Lydekker. Part of the right ramus of the mandible, showing the two last premolars (pm. 3, pm. 4), and the three true molars (m. 1, m. 2, m. 3). Collected by Mr. Theobald in the Siwaliks of Jabi, in the Punjab. (No. C. 172, Ind. Mus.). These teeth are characterised by an unusual quantity of cement.
- Fig. 5. *EQUUS*, sp. Part of the right ramus of the mandible, showing the three true molars. From the collection of the Asiatic Society of Bengal; obtained by the late Conductor J. Dawe near Nahan. (No. C. 173, Ind. Mus.).
- All the specimens are represented of the natural size, and are viewed from the outer side.

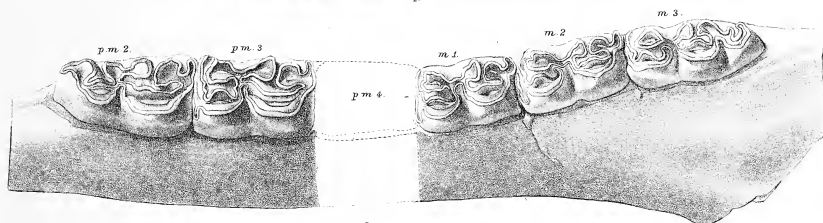
TERTIARY VERTEBRATA.

Geol. Surv. of India.

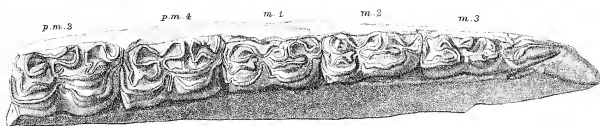
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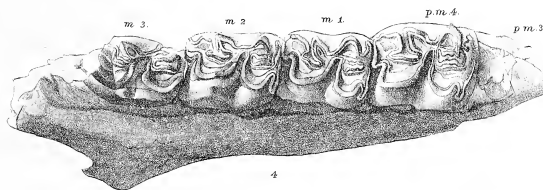
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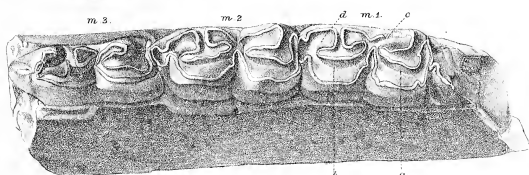
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PLATE XIII.

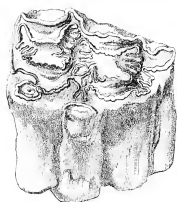
HIPFOTHERIUM THEOBALDI Lyd.

- Fig. 1. Third, or fourth left upper premolar, collected by Mr. Theobald in the Siwaliks of the Punjab. (No. C. 157, Ind. Mus.).
- Fig. 2. Second right upper premolar, collected by Mr. Theobald in the Siwaliks of the Punjab. (No. C. 155, Ind. Mus.).
- Fig. 3. Bones of the anterior foot: the terminal phalange of the middle digit is broken: the three lateral phalanges on the left side of the specimen (right side of figure), and the right lateral metacarpal, have been restored from the corresponding bones of the opposite side. The specimen was collected by Mr. Theobald in the Siwaliks of Niki, in the Punjab, and not improbably belonged to the same individual as the upper jaw represented in figure 3 of plate XI.

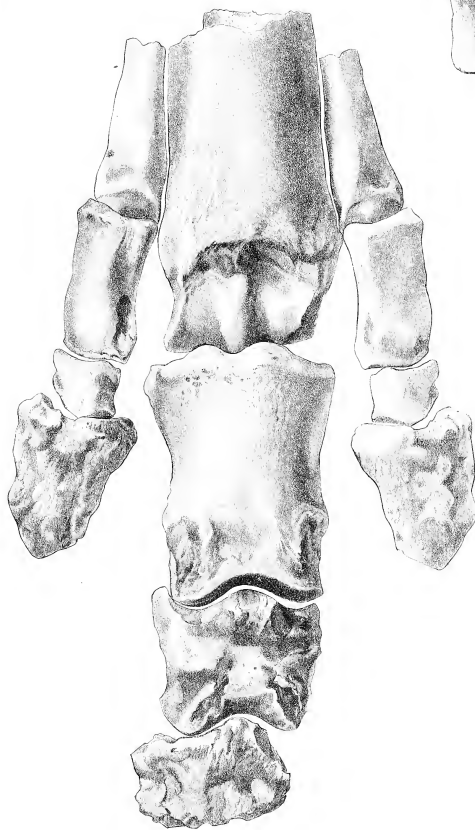
All the specimens are represented of the natural size.



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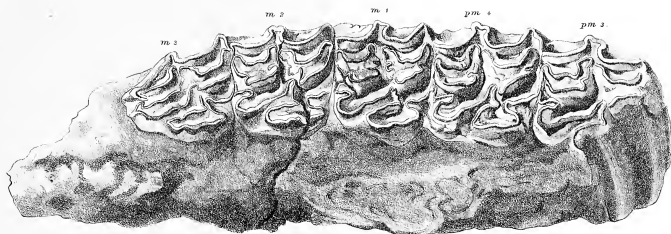
PLATE XIV.

- Fig. 1. *EQUUS SIVALENSIS*. Falc. and Caut. Part of the right maxilla, exhibiting the third and fourth premolars, and the three true molars: from a specimen collected by Mr. Theobald in the higher Siwaliks of the village of Rúpúr, in the Punjab. (No. C. 181, Ind. Mus.).
- Fig. 2. *EQUUS SIVALENSIS*. Falc. and Caut. The complete permanent molar dentition of the left side, from a skull collected by Mr. Theobald in the higher Siwaliks, near the village of Pádri, in the Punjab. The teeth are in an intermediate condition of wear. (No. C. 179, Ind. Mus.)
- Fig. 3. *EQUUS NAMADICUS*. Falc. and Caut. Part of the left maxilla, showing the base of the first premolar (pm. 1), and the whole of the remaining molar teeth of the permanent series. From a specimen collected by Mr. Theobald in the topmost Siwaliks of the Hushiárpúr district. Since the specimen was figured, the second premolar (pm. 2) has unfortunately crumbled to pieces. (No. C. 194, Ind. Mus.)
- All the specimens are represented of the natural size.

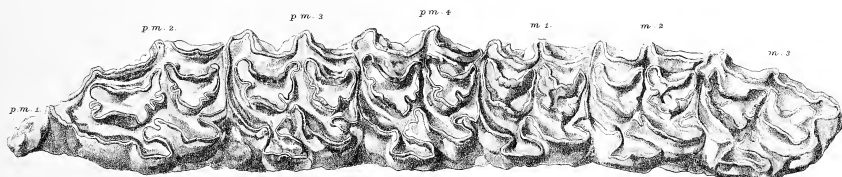
TERTIARY VERTEBRATA

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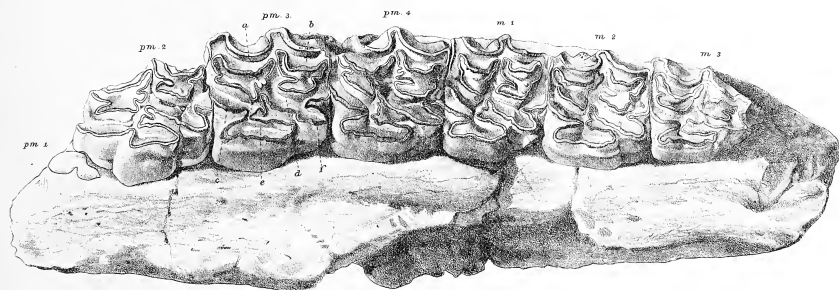
Vol. II Pl. XIV.



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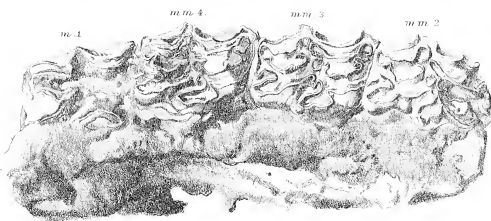
PLATE XV.

- Fig. 1. *EQUUS SIVALENSIS*. Falc. and Caut. Fragment of the right maxilla of a colt, about one year old, showing the three last milk-molars (mm. 2 to mm. 4), and the germ of the first true molar. From a specimen collected by Mr. Theobald in the topmost Siwaliks of the Hoshiárpúr district. (No. C. 182, Ind. Mus.).
- Fig. 2. *EQUUS NAMADICUS*. Falc. and Caut. Fragment of the right maxilla of a colt, about two years old, showing the first milk-molar (m. 1), parts of the second milk-molar and second premolar (mm. 2. pm. 2), the third and fourth milk-molars (mm. 3, mm. 4), and the first true molar (m. 1). From a specimen collected in the Narbada valley by Mr. Hackett. (No. F. 3, Ind. Mus.).
- Fig. 3. *EQUUS NAMADICUS*. Falc. and Caut. Fragment of the left maxilla, showing the base of the first premolar (pm. 1), the three latter premolars (pm. 2-4), and the first true molar (m. 1). The teeth are in an early state of wear. From a specimen collected by Mr. Hackett in the Narbada valley. (No. F. 2, Ind. Mus.).
- Fig. 4. *EQUUS NAMADICUS*. Falc. and Caut. Fragment of the right maxilla, showing three premolars (pm 2. to 4), and the first true molar (m. 1); the teeth are well worn. Collected by Mr. Theobald in the higher Siwaliks of the Kangra district. (No. C. 195, Ind. Mus.).
- All the specimens are represented of the natural size.

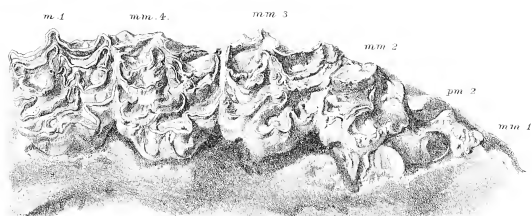
TERTIARY VERTEBRATA

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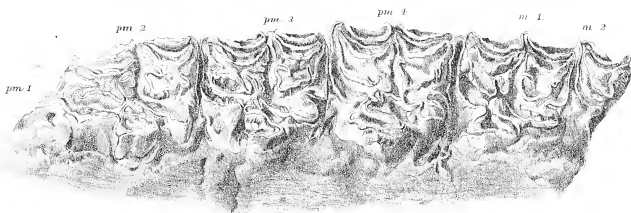
Vol. 2, Pl. 1



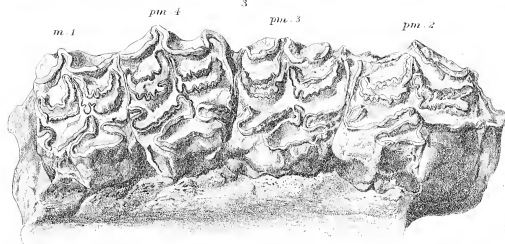
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PLATE XVI.

- Fig. 1. *CAMELOPARDALIS SIVALENSIS*, Falc. and Caut. Part of the right maxilla, containing the third and fourth premolars (pm. 3, pm. 4), and the first and second true molars (m. 1, m. 2); from a specimen collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 184.)
- Fig. 2. Part of the left maxilla of the same individual as the last; the specimen shows the three true molars (m. 1, m. 2, m. 3).
- Fig. 3. *HYDASPHTHERIUM MEGACEPHALUM*, Penultimate left lower milk-molar; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 176.)
- Fig. 4. *UNDETERMINED*. Second lower milk or premolar of a giraffoid animal; collected by Mr. Theobald in the Siwaliks of the Punjab.
- Fig. 5. *CAMELOPARDALIS SIVALENSIS*, Falc. and Caut. Part of the right ramus of the mandible, showing the base of the third premolar (pm. 3), the fourth premolar (pm. 4), the first true molar (m. 1), the base of the second true molar (m. 2), and the third true molar (m. 3). The specimen was collected by Mr. Theobald in the Siwaliks of the Punjab, and probably belonged to the same individual as the upper molars represented in figures 1 and 2. (Ind. Mus., No. B. 173.)
- Fig. 6. *CAMELOPARDALIS SIVALENSIS*, Falc. and Caut. The last right lower true molar of a small individual, implanted in a fragment of the mandible; collected by Mr. Theobald in the Siwaliks of the Punjab, in a low horizon. (Ind. Mus., No. B. 179.)
- Fig. 7. (?) *VISHNUTHERIUM IRAVADICUM*, Lydekker. The second and third upper true molars of the right side, but slightly abraded by wear; collected by Mr. Theobald in the Siwaliks of Asnot, in the Punjab. (Ind. Mus., No. B. 139.)
- Fig. 8. *CAMELOPARDALIS SIVALENSIS*, Falc. and Caut. Last right lower milk-molar of an extreme young fawn; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 175.)

All the figures are drawn of the natural size.

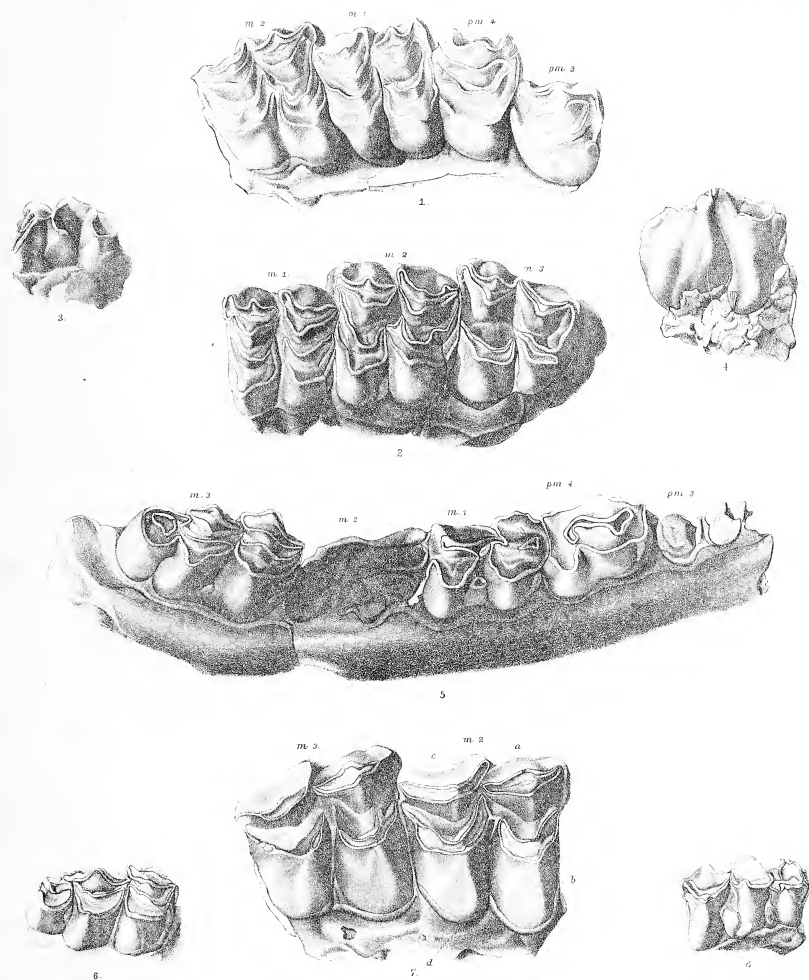


PLATE XVII.

- Fig. 1. *SIVATHERIUM GIGANTEUM*, Falc. and Caut. Right metacarpal; Siwalik: copied from plate B., fig. 15 of "Fauna Antiqua Sivalensis."
- Fig. 2. (?) *SIVATHERIUM GIGANTEUM*, Falc. and Caut. Left metatarsal; Siwalik: copied from plate E, fig. 12 of "Fauna Antiqua Sivalensis."
- Fig. 3. (?) *VISHNUTHERIUM IRAVADICUM*, Lyd. Left metatarsal, wanting distal extremity; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 286.)
- Fig. 4. *HELLADOTHERIUM DUVERNOYI*, Gaud. and Lart. Metatarsal; Pikerimi: copied from plate XLIII of "Animaux Fossiles et Géologie de l'Attique."
- Fig. 5. *HELLADOTHERIUM DUVERNOYI* (Gaud. and Lart.) Metacarpal; Pikerimi: copied from plate XLIII of "Animaux Fossiles et Géologie de l'Attique."
- Fig. 6. *BRAMATHERIUM PERIMENSE*, Falc. Proximal phalangeal; Perim Island. (Ind. Mus., No. B. 271.)
- Fig. 7. *HYDASPITHERIUM MEGACEPHALUM*, Lyd. Left calcaneum; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 284.)
- Fig. 8. (?) *HYDASPITHERIUM GRANDE*, Lyd. Proximal phalangeal; collected by Mr. Theobald in the Siwaliks of Niki in the Punjab. (Ind. Mus., No. B. 172.)
- Fig. 9. *SIVATHERIUM GIGANTEUM*, Falc. and Caut. Proximal phalangeal of the hind foot; collected by Mr. Theobald in the Siwaliks of the Kangra District. (Ind. Mus., No. B. 270.)
- Figs. 10 & 11. *HYDASPITHERIUM MEGACEPHALUM*, Lyd. Associated left metacarpal and proximal phalangeal; collected by Mr. Theobald in the Siwaliks of Niki in the Punjab. (Ind. Mus. No. B. 276.)

Figs. 1, 2, 3, 4, 5, 10, $\frac{1}{2}$ natural size; the others $\frac{1}{2}$ natural size.





PLATE XVIII.

- Fig. 1. (?) *HYDASPITHERIUM GRANDE*, Lyd. Right calcaneum; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 370.)
- Fig. 2. (?) *VISHNUTHERIUM IRABADICUM*, Lyd. Part of a sixth cervical vertebra, viewed from the left side; collected by Mr. Theobald in the Siwaliks of Asnot in the Punjab. (Ind. Mus., No. B. 373.)
- Fig. 3. *HYDASPITHERIUM MEGACEPHALUM*, Lyd. Second and third left upper true molar; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 135.)

Figs. 1 one-half the natural size; figs. 2 and 3 natural size.

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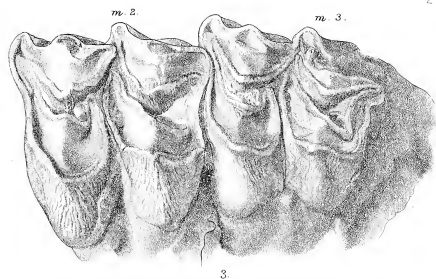
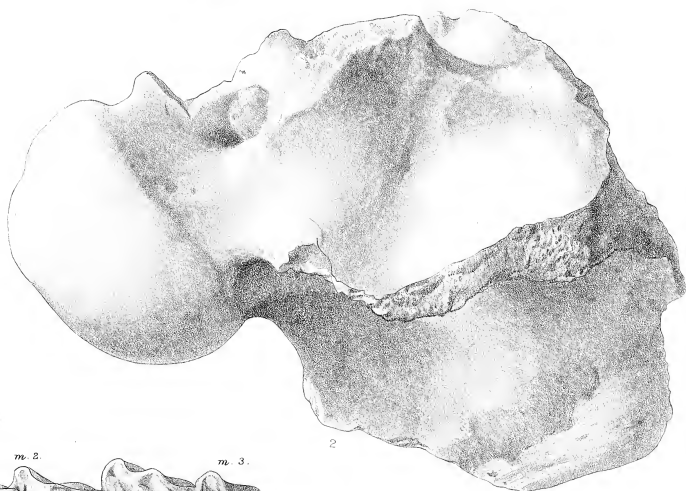
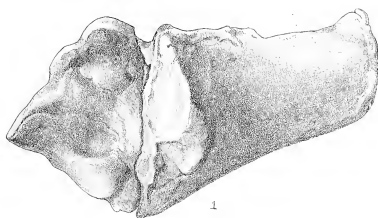


PLATE XIX.

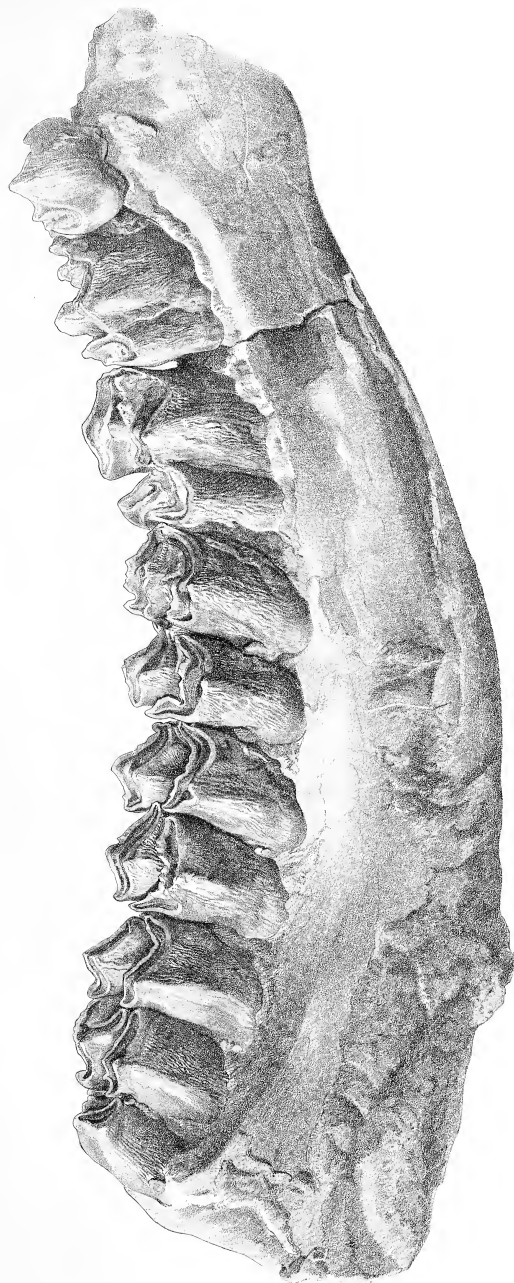
- (?) *HYDASPITHERIUM MEGACEPHALUM*, Lyd. Right ramus of the mandible, viewed from the outer side; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus. No. B. 142.) Natural size.

Owing to a misconception on the part of the Artist only the horizontal ramus of this specimen has been figured, instead of the nearly complete ramus as stated in the text.

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PLATE XX.

- (?) *HYDASPITHERIUM GRANDE*, Lyd. Left ramus of the mandible, viewed from the outer (fig. 1) and inner (fig. 2) sides; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 151.) Natural size.



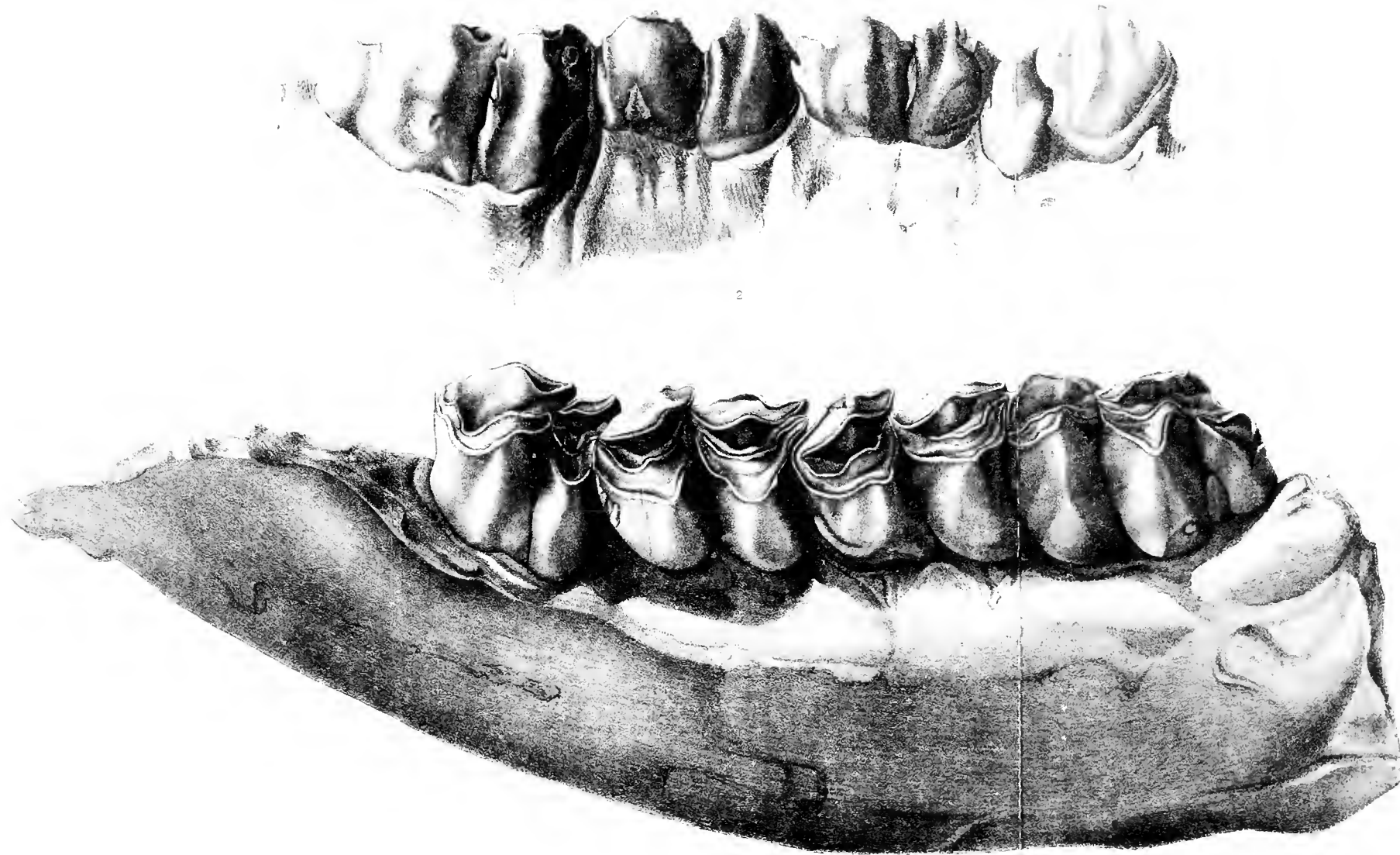
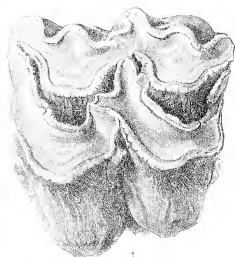




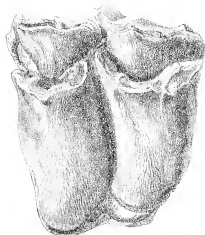
PLATE XXI.

- Fig. 1. *SIVATHERIUM GIGANTEUM*, Falc. and Caut. First or second left upper true molar ; collected by Mr. Theobald in the Siwaliks of the Kangra district. (Ind. Mus., No. B. 163.)
- Fig. 2. *HYDASPITHERIUM GRANDE*, Lyd. Second left upper true molar ; collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 155.)
- Fig. 3. *SIVATHERIUM GIGANTEUM*, Falc. and Caut. Part of left ramus of the mandible of a fawn, showing third and fourth milk-molars, and part of first true molar ; from a specimen collected in the Siwaliks near Rúrki. (Ind. Mus., No. B. 341.)
- Fig. 4. *HYDASPITHERIUM*, Sp. Part of right ramus of the mandible of a fawn, showing third and fourth milk-molars ; from a specimen collected by Mr. Theobald in the Siwaliks of the Punjab. (Ind. Mus., No. B. 149.)

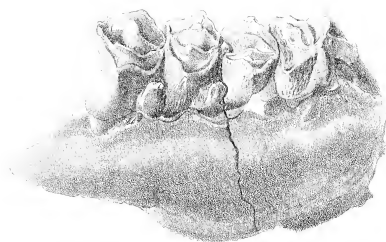
All the specimens are drawn of the natural size.



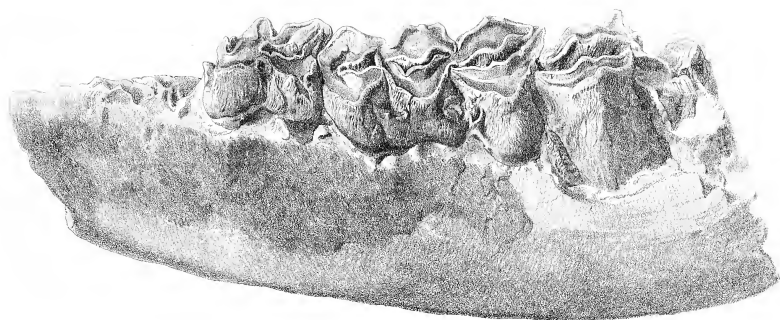
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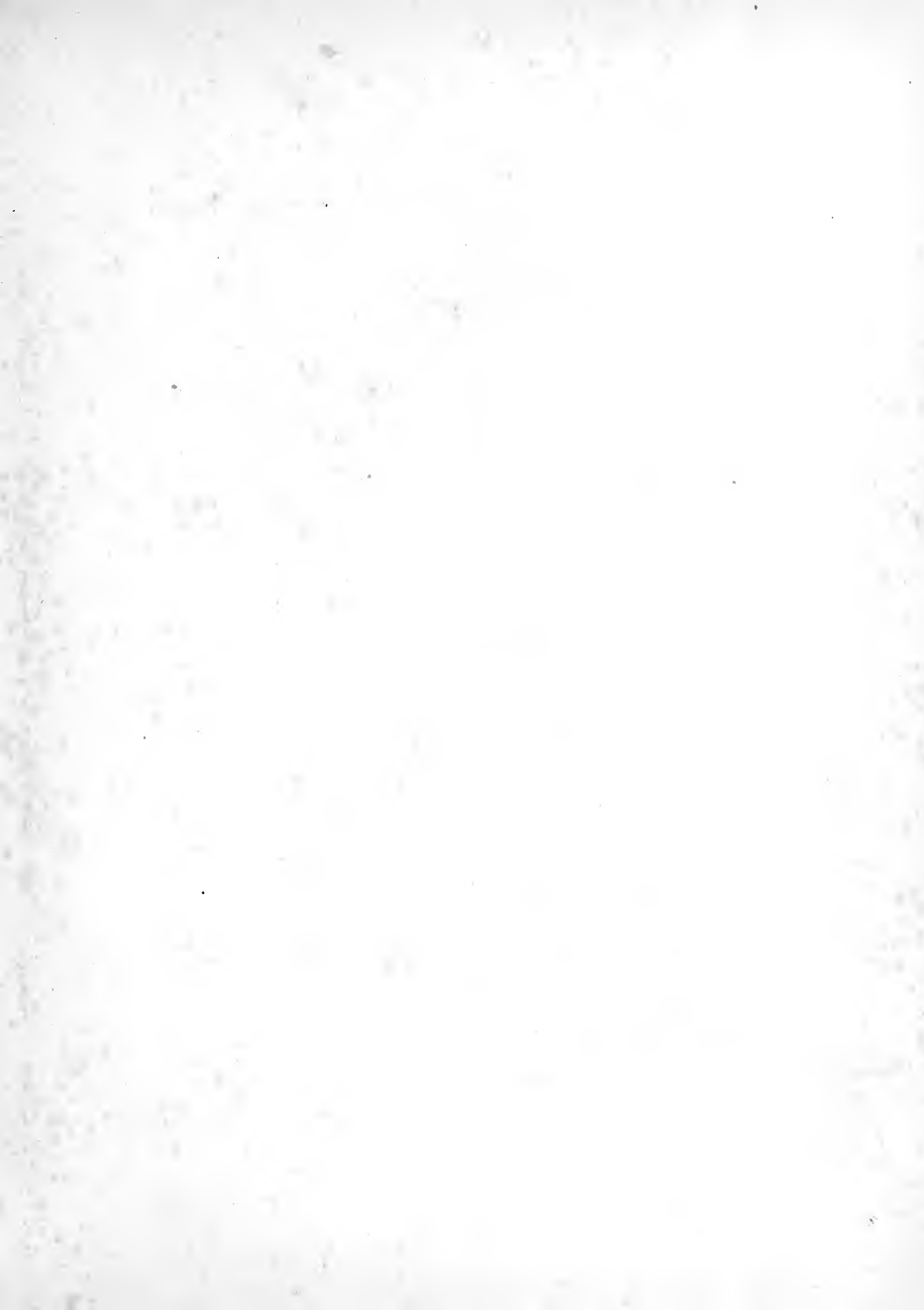


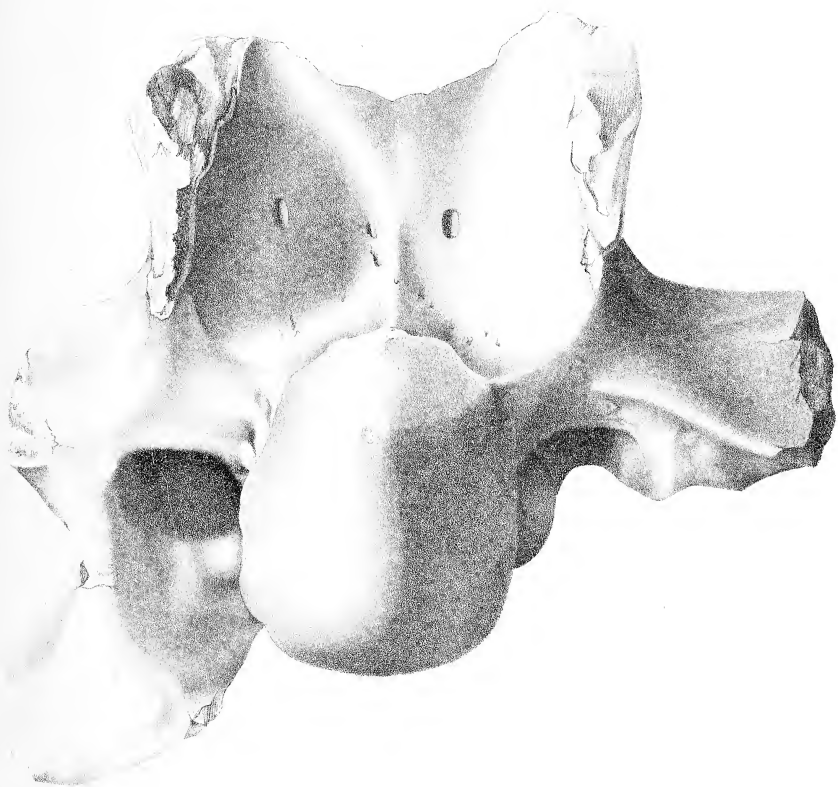
PLATE XXII.

SIVATHERIUM GIGANTEUM, Falc. and Cant. Sixth cervical vertebra, viewed from the preaxial aspect; from the Siwaliks of the neighbourhood of Rúrki. (Ind. Mus., No. B. 374.)
Natural size.

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Nilkanta Das, Lith.

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PLATE XXIII.

- Fig. 1. *HEMIMERYX BLANFORDI* (?), Lydekker. Left lower true molar, in an early stage of wear, viewed from the grinding surface. (No. B. 90, Ind. Mus.)
- „ 2. *AGRIOTHERUS* (?) sp. Left upper true molar, scarcely touched by wear, viewed from the grinding and inner aspects. (No. B. 94, Ind. Mus.)
- „ 3. *HYOPOTAMUS PALEINDICUS* (?) Lydekker. Third left lower true molar, wanting the third column, in an intermediate stage of wear, viewed from the grinding and inner aspects. (No. B. 84 Ind. Mus.)
- „ 4. *HYOPOTAMUS PALEINDICUS*, Lydekker. Right upper true molar, in a very early stage of wear, viewed from the grinding surface. (No. B. 83, Ind. Mus.)
- „ 5. *HEMIMERYX BLANFORDI*, Lydekker. Left upper true molar, in a very early stage of wear, viewed from the grinding surface. (No. B. 89, Ind. Mus.)
- „ 6. *HYOPOTAMUS PALEINDICUS*, Lydekker. Left upper true molar, in an intermediate stage of wear, viewed from the grinding surface. (No. B. 82, Ind. Mus.)
- „ 7. External aspect of fig. 4.
- „ 8. External aspect of fig. 5.: the figure is reversed, the points of the lobes should have been directed downwards as in fig. 7.
- „ 9. External aspect of fig. 6.
- „ 10. *ANTHRACOTHERIUM SILISTRENSE*, Pentland. Third right upper true molar, in an early stage of wear, viewed from the grinding surface. (No. B. 103, Ind. Mus.)
- „ 11. *SIVAMERYX SINDIENSIS*, Lydekker. Right upper true molar, scarcely touched by wear, viewed from the grinding surface. (No. B. 91, Ind. Mus.)
- „ 12. *ANTHRACOTHERIUM SILISTRENSE*, Pentland. Second right upper true molar, scarcely touched by wear, viewed from the grinding surface. (No. B. 103, Ind. Mus.)

All the specimens were collected by Messrs W. T. Blanford, and F. Fedden in the lower Manchhars (Sivaliks) of Sind, and are represented of the natural size.

[The heading of the plate should be "Tertiary Vertebrata," in place of "Tertiary Mammalia."].



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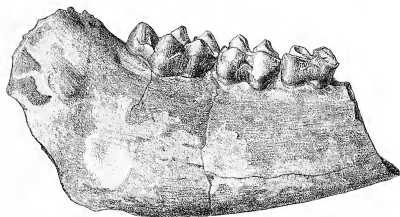
PLATE XXIV.

- Fig. 1. 1a. *ANTHRACOTHERIUM SILISTRENSE*, Pentland. Part of the right ramus of the mandible, showing the three true molars, in an early stage of wear. Collected by Mr. Theobald in the Siwaliks of the Punjab. (No. B. 106, Ind. Mus.), fig. 1, viewed from the grinding surface; 1a. from the outer side.
- „ 2. *ANTHRACOTHERIUM HYOPOTAMOIDES*, Lydekker. Part of the right maxilla showing the third true molar, and the base of the second. Collected by Mr. W. T. Blanford in the lower Manchhars (Siwaliks) of the Bhūgti hills, north of Sind. (No. B. 426, Ind. Mus.) The specimen is viewed from the grinding surface, and the one remaining tooth is but slightly touched by wear.
- „ 3. *HYOPOTAMUS GIGANTEUS*, Lydekker. The third upper true molar of the left side, in an intermediate stage of wear, and viewed from the grinding surface. (No. B. 427, Ind. Mus.); same history as last specimen.
- „ 4. *HYOPOTAMUS PALÆINDICUS* (?) Lydekker. Part of the left ramus of the mandible, showing the bases of the second and third true molars. Collected by Mr. Fedden in the lower Manchhars of Sind, and viewed from the outer side. (No. B. 85, Ind. Mus.)

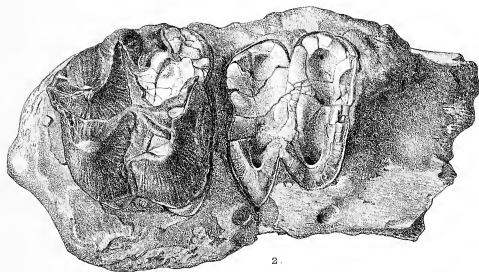
All the specimens are represented of the natural size.



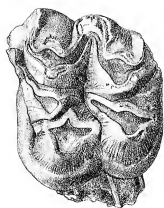
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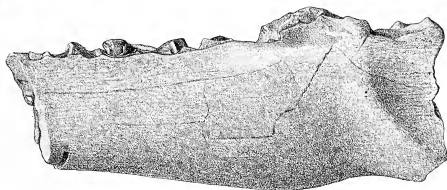
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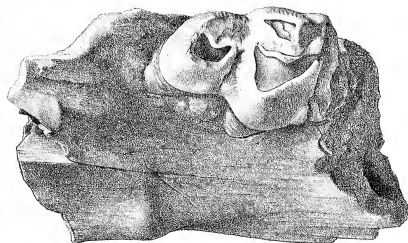
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PLATE XXV.

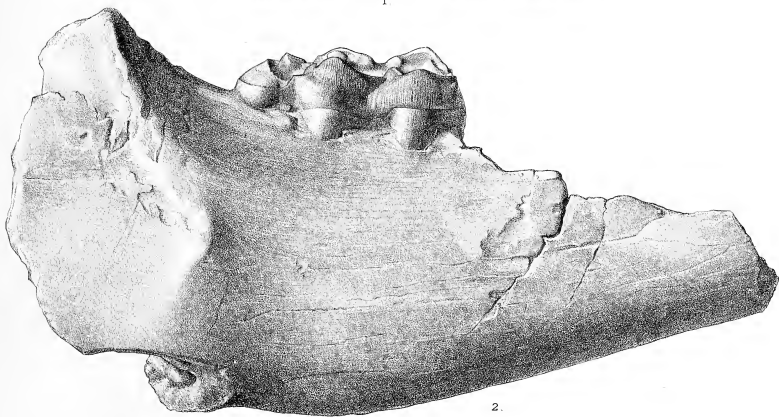
- Fig. 1. *ANTHRACOTHERIUM HYOPOTAMOIDES* (?) Lydekker. Fragment of the hinder extremity of the right ramus of the mandible, showing a part of the last true molar. (No. B. 430, Ind. Mus.)
- „ 2. *HYOPOTAMUS GIGANTEUS* (?) Lydekker. Portion of the hinder extremity of the right ramus of the mandible, showing the last true molar. (No. B. 428, Ind. Mus.)
- „ 3. *ANTHRACOTHERIUM HYOPOTAMOIDES* (?) Lydekker. Fragment of the middle portion of the right ramus of the mandible, showing a part of the first, and the whole of the second true molar. (No. B. 429, Ind. Mus.)
-

All the specimens were collected by Mr. W. T. Blanford, from the lower Manchhar rocks of the Bhūgti hills, to the north of the Sind frontier, and are represented of the natural size. Fig. 2 is viewed from the outer aspect; while figures 1 and 3 are viewed obliquely from both the upper and outer aspects.

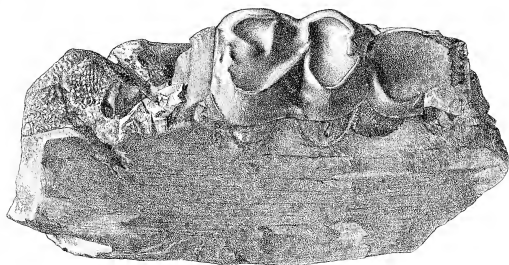
[The heading of the plate should be “Tertiary Vertebrata,” in place of “Tertiary Mammalia.”]



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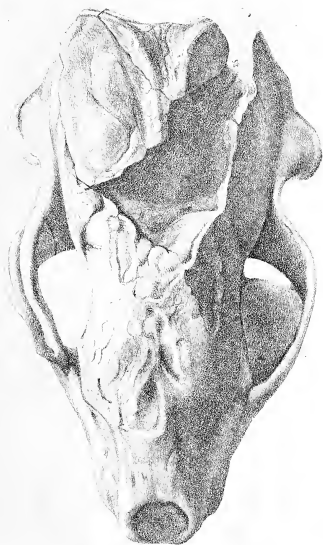
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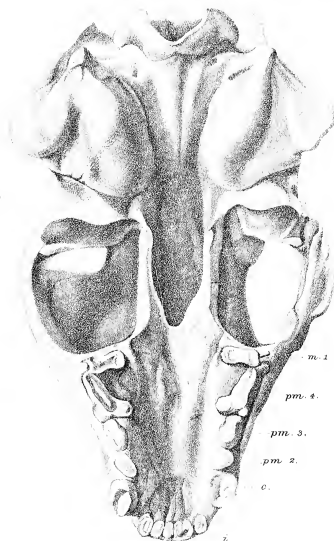
PLATE XXVI.

CARNIVORA — *Mustelidae*.

Figs. 1-4. *MELLIVORA SIVALENSIS*, Falc. and Caut. Four views of a cranium from the Siwaliks; British Museum (No. 40,181) †.: fig. 1 parietal, fig. 2 palatal, fig. 3 left lateral, fig. 4 occipital aspect



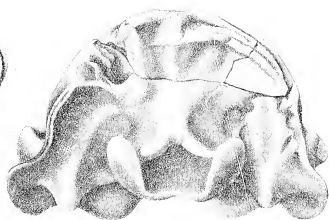
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PLATE XXVII.

CARNIVORA — *Mustelidae*.

- Fig. 1. LUTRA PALÆINDICA, Falc. and Caut. Palatal aspect of cranium, from the Siwaliks; British Museum (No. 37,151).
- „ 2, 2a. LUTRA PALÆINDICA, Falc. and Caut. Left ramus of mandible, from the Siwaliks; British Museum (No. 37,152); fig. 2 from the outer, 2a from the dental aspect.
- „ 3, 3a. LUTRA BATHYGNATHUS, Lyd. Part of left ramus of mandible, from the Siwaliks of the Punjab: Indian Museum (No. D. 33); fig. 3 from the inner, 3a from the dental aspect.
- „ 4. LUTRA BATHYGNATHUS, Lyd. Hinder part of left ramus of mandible, from the Siwaliks of the Punjab: Indian Museum (No. D. 34): from the inner aspect.
- „ 5. LUTRA SIVALENSIS (Falc. and Caut). Palatal aspect of cranium, from the Siwaliks: Museum of Royal College of Surgeons (No. 777A.)
- „ 6, 6a. MELLIVORA PUNJABIENSIS, Lyd. Anterior part of right ramus of mandible, from the Siwaliks of the Punjab: Indian Museum (No. D. 20): fig. 6 from the outer, 6a from the dental aspect.
- „ 7, 7a. MELLIVORODON PALÆINDICUS, Lyd. Anterior part of left ramus of mandible, from the Siwaliks of the Punjab: Indian Museum (No. D. 21): fig. 7 from the outer, 7a from the dental aspect.
- „ 8. MELLIVORODON PALÆINDICUS, Lyd. Hinder part of left ramus of mandible, from the Siwaliks of the Punjab: Indian Museum (No. D. 22), from the outer aspect.

All the figures natural size.

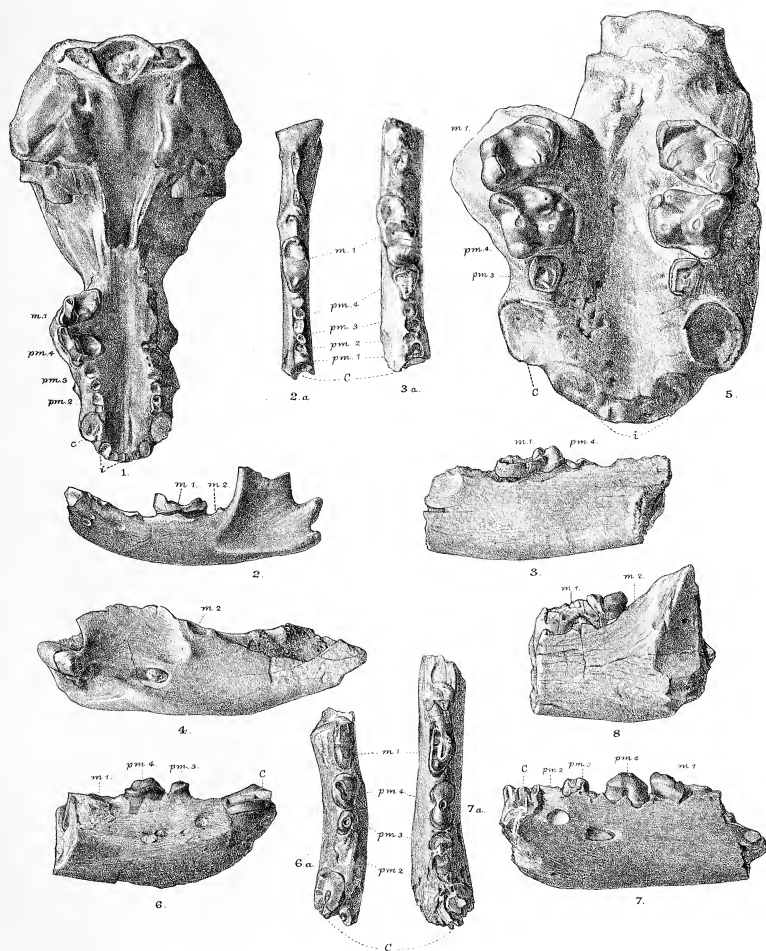


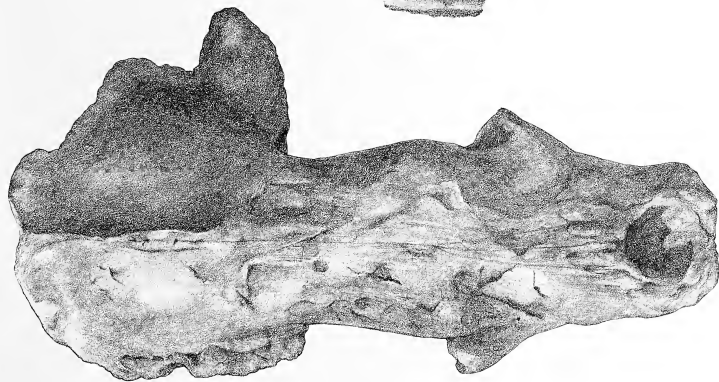


PLATE XXVIII.

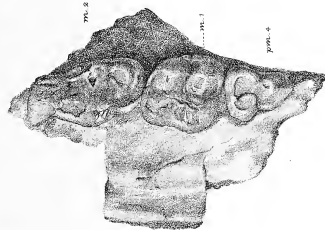
CARNIVORA — *Ursidae* (*Ursinae*).

Fig. 1-2. *URSUS THEOBALDI*, Lyd. Frontal and palatal aspects of cranium, from the Siwaliks of the Kangra district: Indian Museum (No. D. 17) $\frac{1}{2}$.

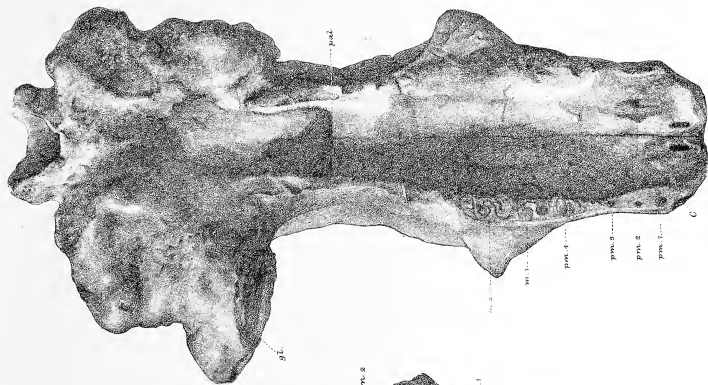
„ 3. *URSUS NAMADICUS*, Falc. and Caut. Part of right maxilla, from the Narbadas: British Museum (No. 39,720), $\frac{1}{4}$.



1



3



2





PLATE XXIX.

CARNIVORA — *Ursidae* (*Ursinae*).

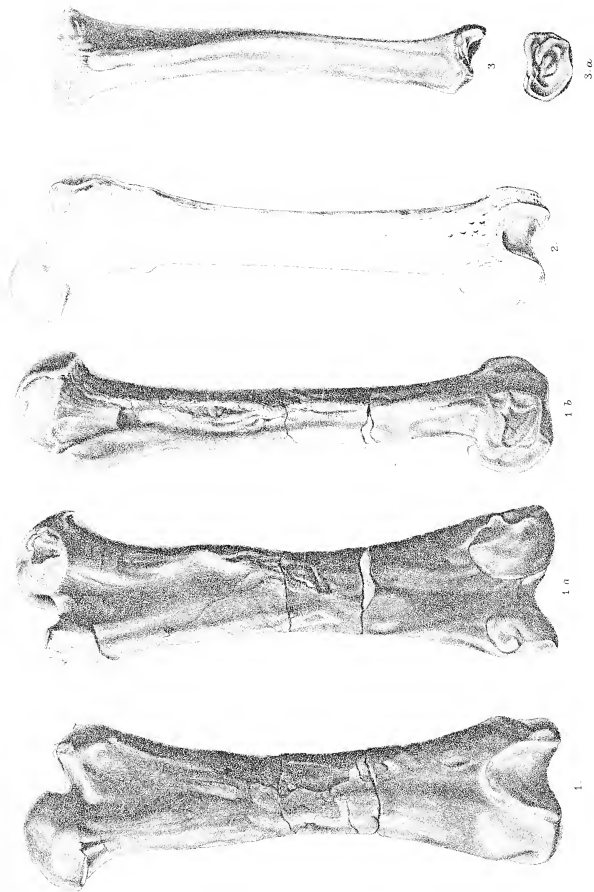
- Fig. 1, 1a, 1b. *HYLENARCTOS SIVALENSIS*, Falc. and Caut. Three views of right femur, from the Siwaliks: British Museum (No. 39,723): fig. 1 from the anterior, 1a from the posterior, and 1b from the inner aspect.
- „ 2. *URSUS SPELÆUS*, Rosenm. Right femur, pleistocene, Europe: anterior aspect.
- „ 3, 3a (?). *URSUS NAMADICUS*, Falc. and Caut. Left tibia, from the Narbadas: British Museum (No. 39,729): fig. 3 from the anterior, 3a from the distal aspect.

All the figures $\frac{1}{2}$ natural size.

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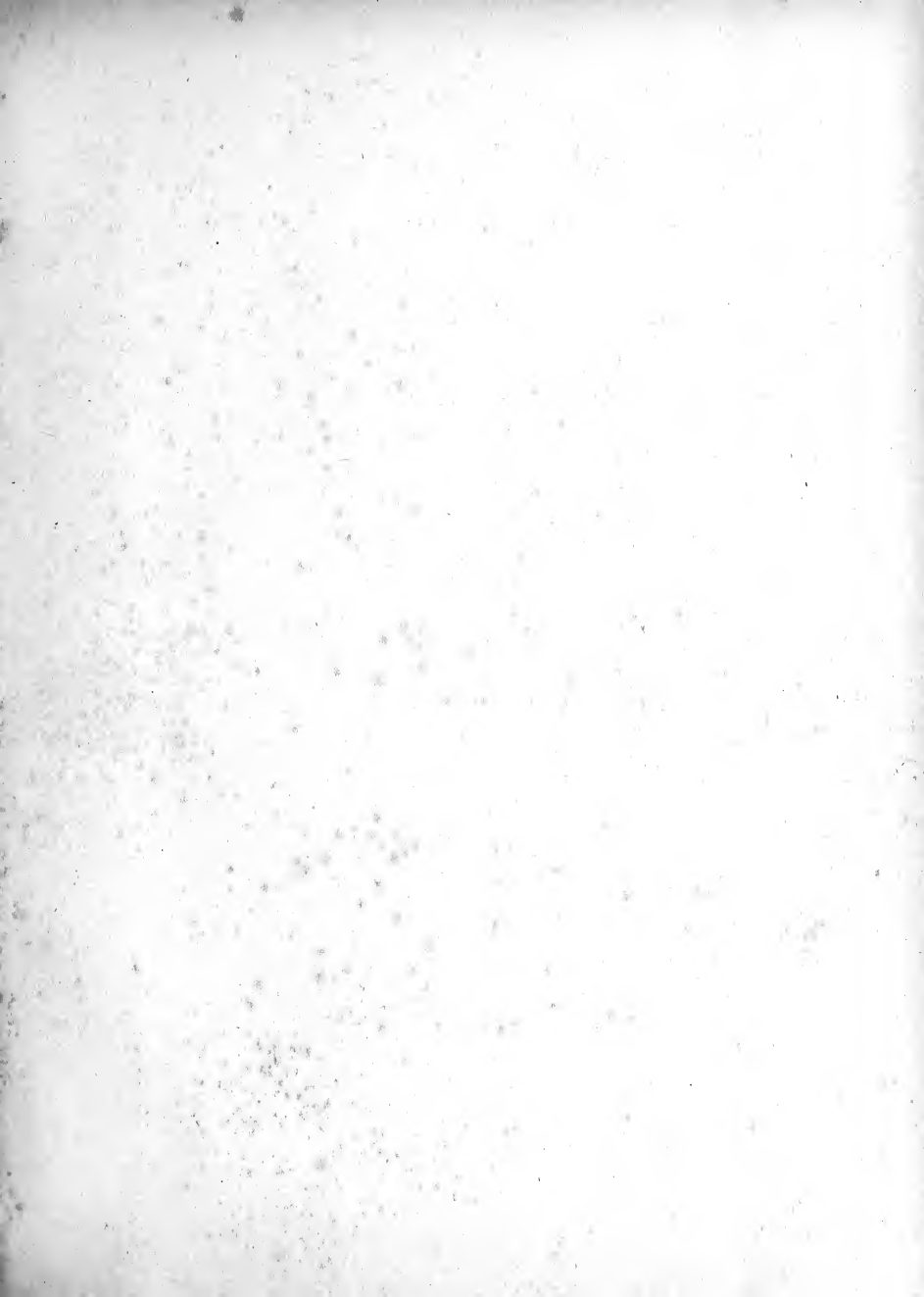


PLATE XXX.

CARNIVORA — *Ursidae* (*Ursinae*).

- Fig. 1. *HYÆNARCTOS PALEINDICUS*, Lyd. Part of right maxilla, from the Siwaliks of the Punjab : Indian Museum (No. D. 16).
- „ 2. *HYÆNARCTOS PUNJABIENSIS*, Lyd. Part of upper cheek-dentition, from the Siwaliks of the Punjab : Indian Museum (No. D. 6) : the outline represents the outer aspect of the teeth of the left side.
- „ 3 (?). *HYÆNARCTOS PALEINDICUS*, Lyd. Right upper canine, from the Siwaliks of the Punjab : Indian Museum (No. D. 11).
- „ 4. UNDETERMINED *URSOID*. Lower (?) canine, from the Siwaliks of Pegu ; Indian Museum (No. D. 18).
- „ 5. *HYÆNARCTOS SIVALENSIS*, Falc. and Caut. Left upper dentition (canine restored from opposite side) of type cranium, from the Siwaliks ; British Museum (No. 39,721).

All the figures natural size.

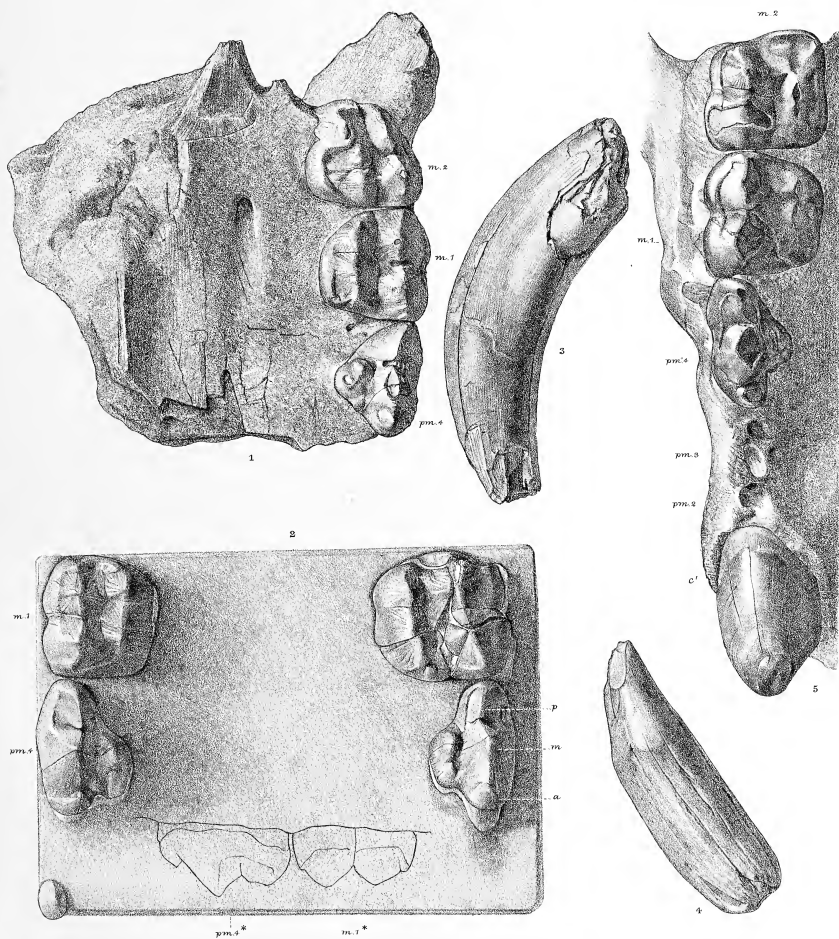




PLATE XXXI.

CARNIVORA — *Ursidae* (*Ursinae*).

- Fig. 1, 1a. *HYÆNARCTOS PUNJABIENSIS*, Lyd. A nearly complete mandible, from the Siwaliks of Asnot, Punjab: Indian Museum (No. D. 8): fig. 1, the right ramus from the outer aspect; 1a from the dental aspect: the left ramus is drawn in outline, and the canine of the right side in fig. 1a is restored from that of the opposite side.
- „ 2. *HYÆNARCTOS* (?) *PALÆINDICUS*, Lyd. Part of left ramus of the mandible from the Siwaliks of Jabi, Punjab: Indian Museum (No. D. 10).
- „ 3. *HYÆNARCTOS* (?) *PALÆINDICUS*, Lyd. Part of right ramus of probably the same mandible: from the Siwaliks of Jabi: Indian Museum (No. D. 9).

All the figures natural size.

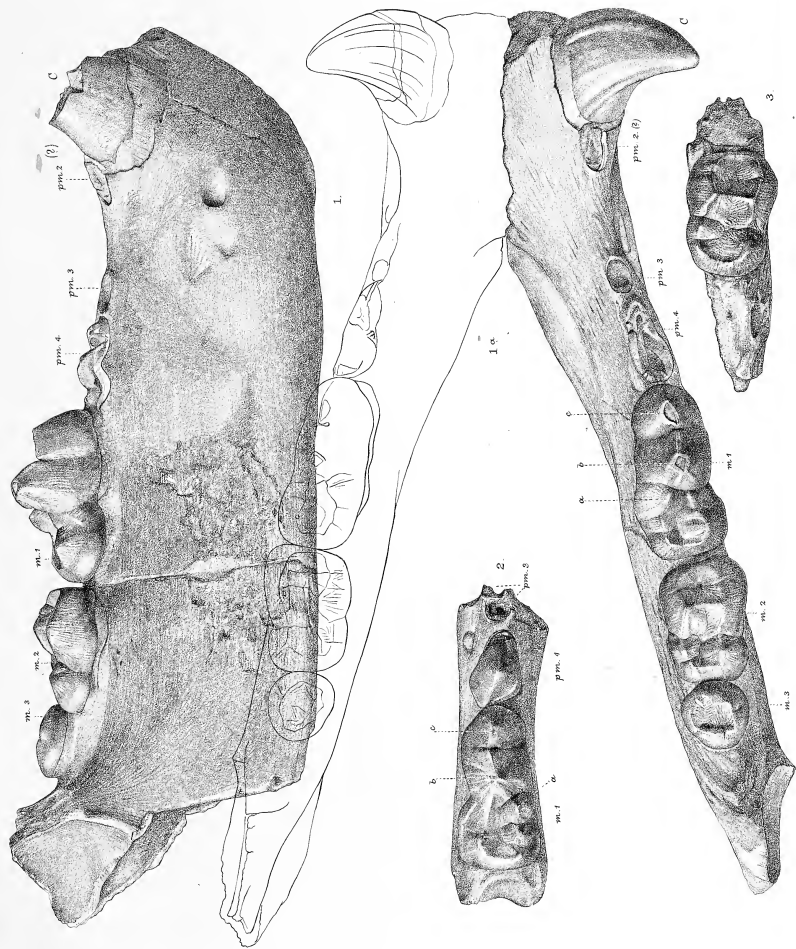




PLATE XXXII.

CARNIVORA — *Ursidae* (*Caninae*).

- Fig. 1, 1a. *CANIS CURVIPALATUS*, Bose. A nearly complete cranium, from the Siwaliks; British Museum (No. 37,149): 1 from the dental, 1a from the parietal aspect.
- „ 2. *CANIS* sp.; allied to *C. aureus*. A portion of the right maxilla from the Siwaliks: British Museum.
- „ 3. *CANIS CAUTLEYI*, Bose. A portion of the left maxilla, from the Siwaliks of Dádápúr: Indian Museum (No. D. 35).
- „ 4 (?). *AMPHICYON PALEINDICUS*, Lyd. Hinder part of right ramus of the mandible, from the lower Siwaliks of Sind: Indian Museum (No. D. 25).
- „ 5, 5a (?). *AMPHICYON PALEINDICUS*, Lyd. Fragment of right ramus of the mandible, from the Siwaliks of Núrpúr: Indian Museum (No. D. 23): 5 from the dental, 5a from the outer aspect.
- „ 6, 6a. *CANIS CAUTLEYI*, Bose. Hinder portion of left ramus of the mandible, from the Siwaliks: British Museum (No. 40,181): 6 from the dental, 6a from the outer aspect.
- „ 7. *CANIS CURVIPALATUS*, Bose. Mandible associated with cranium represented in fig. 1: from the dental aspect. British Museum (No. 37,149).
- „ 8. *AMPHICYON PALEINDICUS*, Lyd. Second (?) right upper true molar, from the Siwaliks of Kúshalghar, Punjab: Indian Museum (No. D. 26).

All the figures natural size.

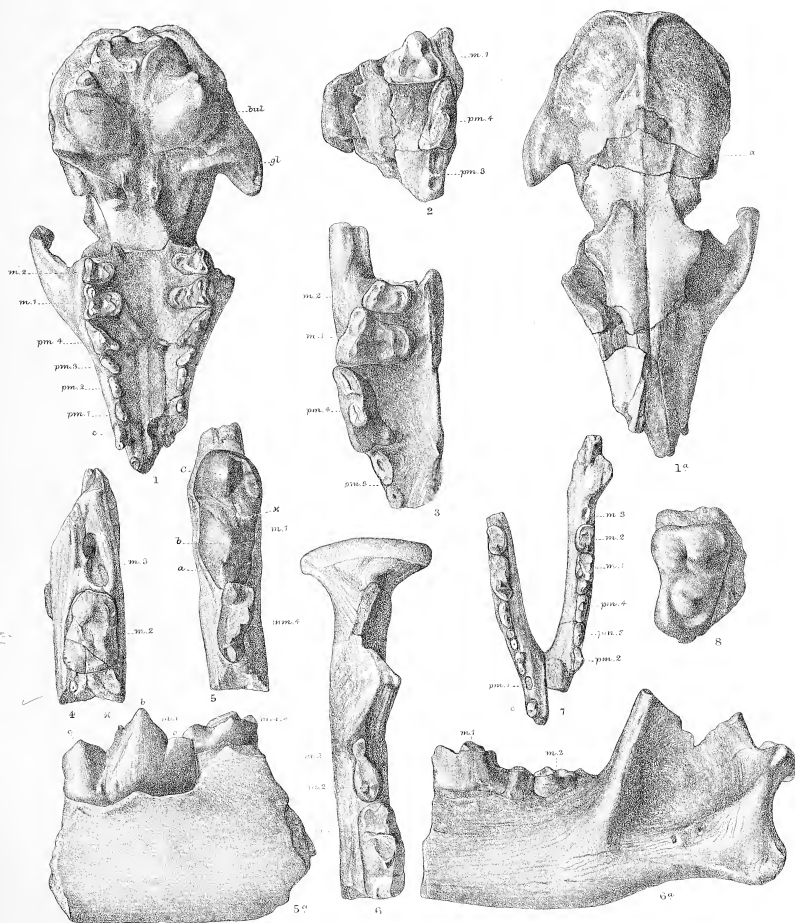




PLATE XXXIII.

CARNIVORA — *Viverridæ* and *Felidæ*.

- Fig. 1, 1a. *VIVERRA BAKERI*, Bose. Cranium, from the Siwaliks: British Museum (No. 40,183): fig. 1 from the palatal, 1a from the frontal aspect.
- „ 2. *VIVERRA BAKERI*, Bose. Part of left maxilla, from the Siwaliks: British Museum (No. 40,180).
- „ 3. *VIVERRA DURANDI*, Lyd. Palatal aspect of cranium, from the Siwaliks: British Museum (No. M. 1,338).
- „ 4, 4a. *ÆLUROPSIS ANNECTANS*, Lyd. Part of right ramus of mandible, from the Siwaliks of Asnot, Punjab: Indian Museum (No. D. 41): 4 from the dental, 4a from the inner aspect.

* All the figures natural size.

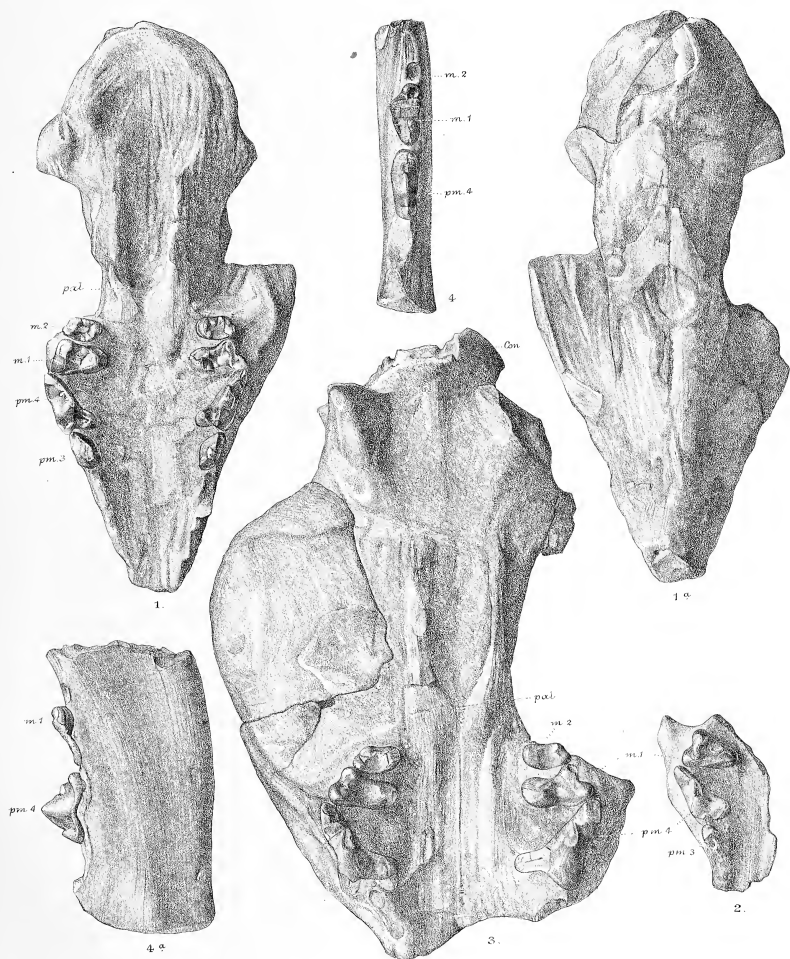




PLATE XXXIV.

CARNIVORA — *Hyænidæ*.

Fig. 1, 2. *HYÆNA SIVAENSIS*, Bose. Palatal and frontal aspects of cranium from the Siwaliks :
British Museum (No. 37,133).

„ 3. Outer surface of left pm. 3 and pm. 4 of same specimen.

All the figures natural size.

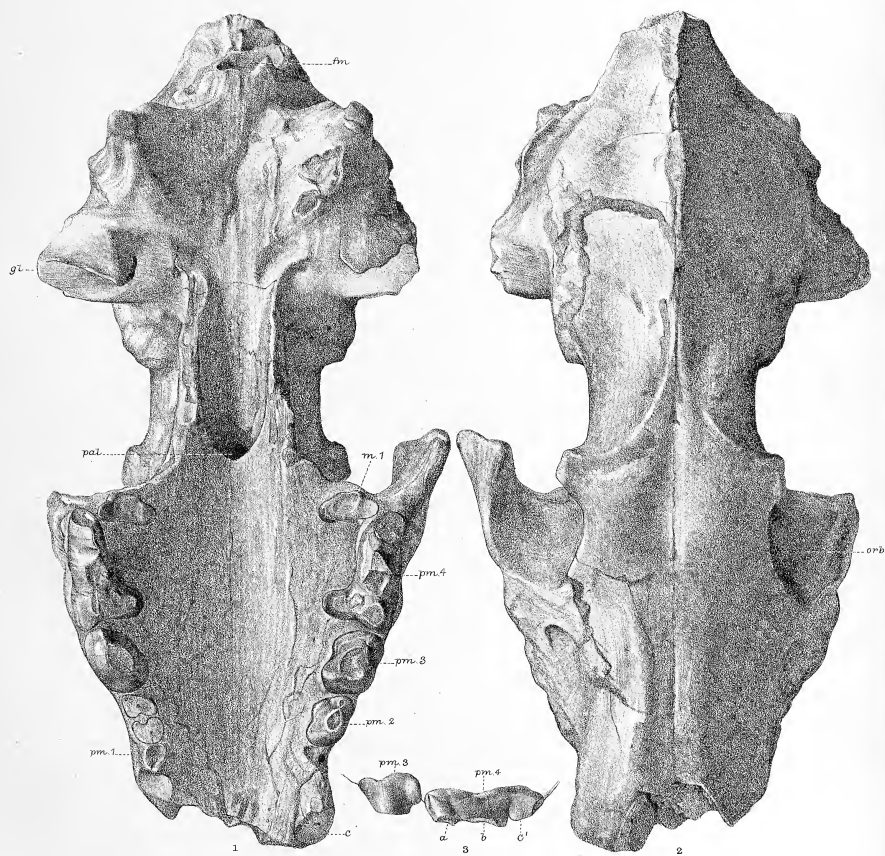


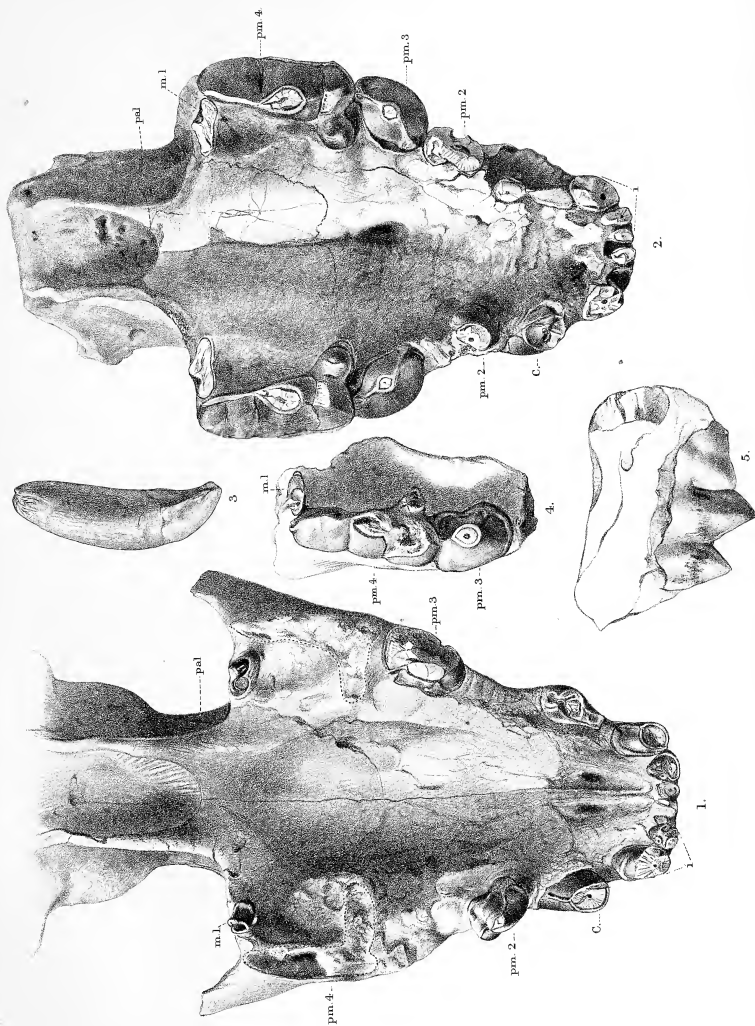


PLATE XXXV.

CARNIVORA — *Hyaenidae*.

- Fig. 1. *HYÆNA COLVINI*, Lyd. Palatal aspect of immature cranium, from the Siwaliks: Indian Museum (No. D. 45).
- „ 2. *HYÆNA COLVINI*, Lyd. Palatal aspect of cranium, from the Siwaliks: Indian Museum (No. D. 47): hinder cheek-teeth of left side restored.
- „ 3 (?). *HYÆNA FELINA*, Bose. Third left upper incisor, from the Siwaliks of the Punjab: Indian Museum (No. D. 55): from the outer aspect.
- „ 4. *HYÆNA COLVINI*, Lyd. Fragment of left maxilla, from the Siwaliks of the Punjab: Indian Museum (No. D. 101).
- „ 5. *HYÆNA COLVINI*, Lyd. Left upper carnassial, from the Siwaliks of the Kangra district: Indian Museum (No. D. 46): from the outer aspect.

All the figures natural size.



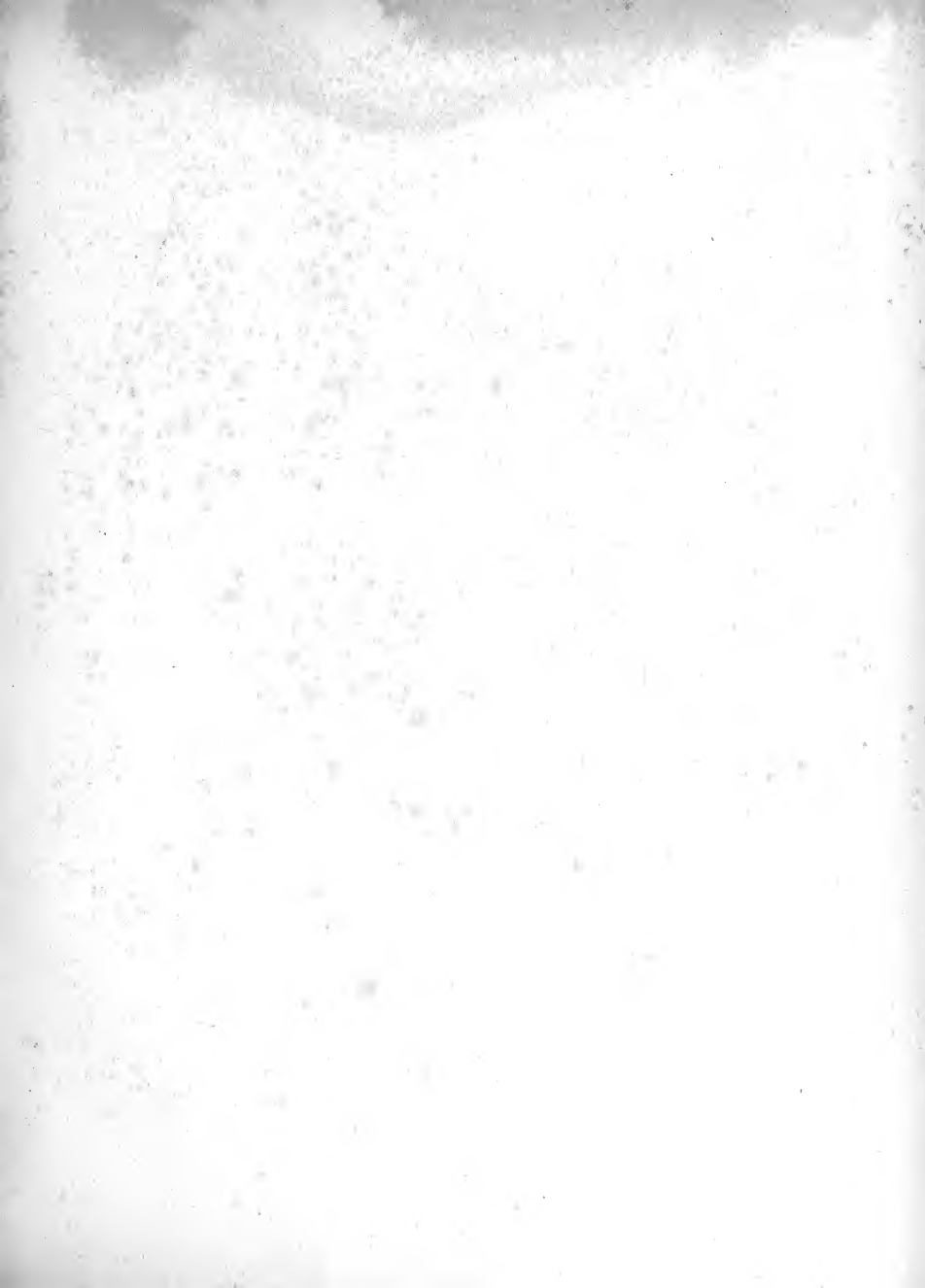


PLATE XXXV A.

CARNIVORA — *Hyænidæ*.

- Fig. 1, 1a. *HYÆNA COLVINI*, Lyd. Part of left maxilla, from the Siwaliks: British Museum (No. 37,139): fig. 1 from the palatal, 1a from the outer aspect.
- „ 2, 2a. *HYÆNA FELINA*, Bose. Part of right maxilla, from the Siwaliks: British Museum (No. 37,138): fig. 2 from the palatal, 2a from the outer aspect.
- „ 3, 3a. *HYÆNA COLVINI*, Lyd. Part of left maxilla from the Siwaliks: British Museum (No. 37,140): fig. 3 from the palatal, 3a from the outer aspect.
- „ 4. *HYÆNA*, *sp. non. def.* Part of right maxilla, from the Siwaliks: British Museum (No. 37,137).

All the figures natural size; reversed.



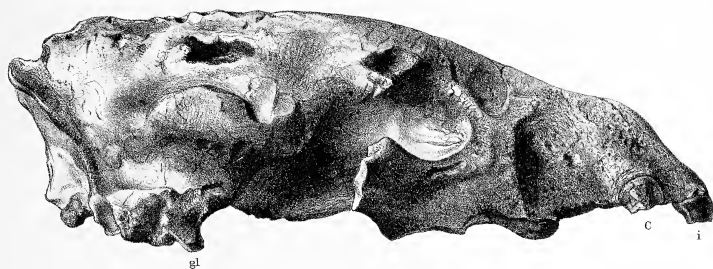
PLATE XXXVI.

CARNIVORA — *Hyænidæ*.

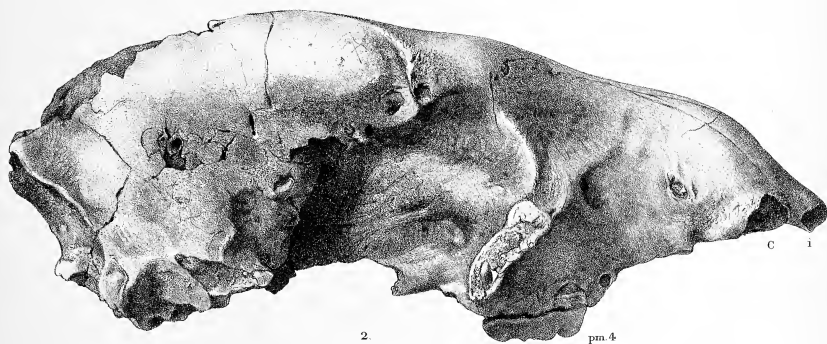
Fig. 1. *HYÆNA COLVINI*, Lyd. Right lateral aspect of the immature cranium represented in plate XXXV., fig. 1.

„ 2. *HYÆNA MACROSTOMA*, Lyd. Right lateral aspect of the cranium represented in plate XXXVII.

Both figures $\frac{2}{3}$ natural size.



1.



2.



PLATE XXXVII.

CARNIVORA — *Hyenidae*.

Figs. 1, 2. *HYENA MACROSTOMA*, Lyd. Upper and lower views of cranium, from the Siwaliks of Jabi,
Punjab: Indian Museum (No. D. 44). 1.

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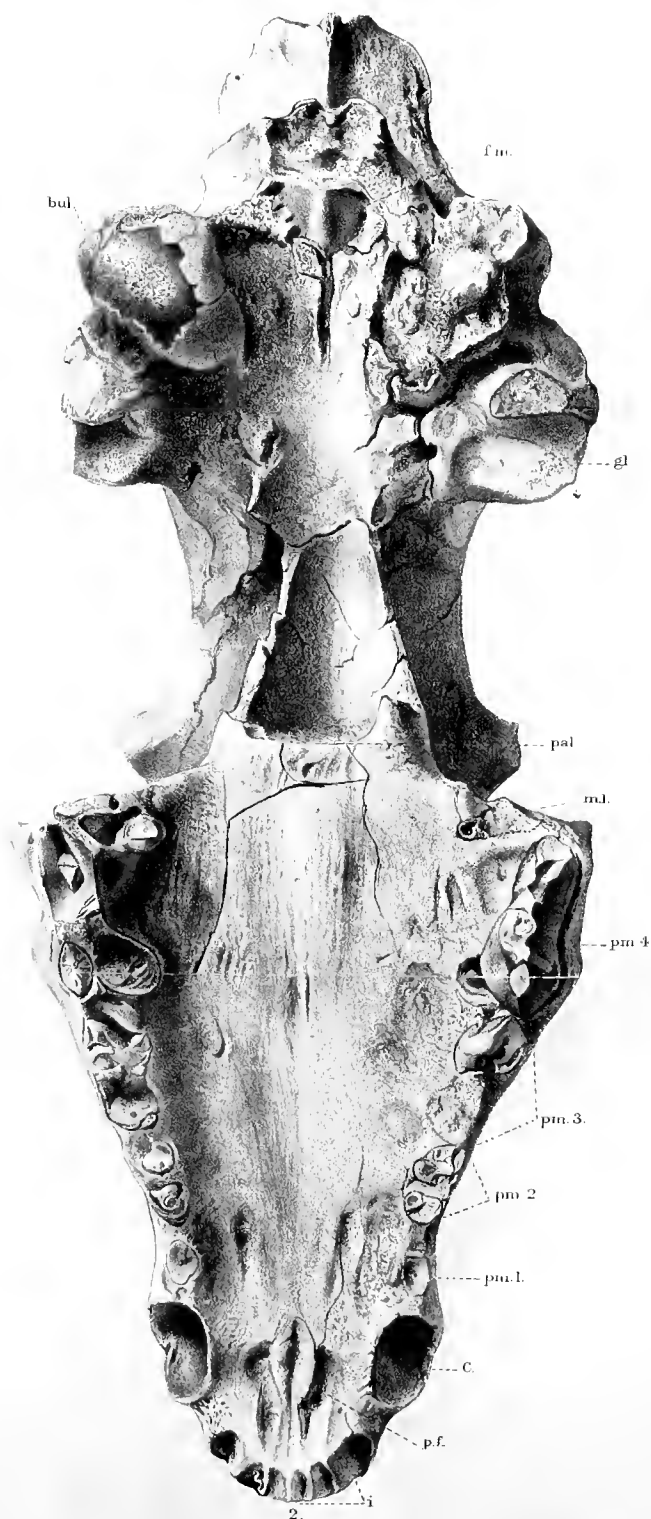
Vol. II. Pl. XXXVII.





Ant. del. et. h. b.

1.



2.

Minter Bros. imp.

PLATE XXXVIII.

CARNIVORA — *Hyenidae*.

- Fig. 1. *HYENA FELINA*, Bose. Part of left ramus of immature mandible, from the Siwaliks of the Jamu district: Indian Museum (No. D. 102).
- „ 2. *HYENA SIVALENSIS*, Bose. Hinder part of right ramus of mandible, from the Siwaliks of Asnot, Punjab: Indian Museum (No. D. 53).
- „ 3. *HYENA COLVINI*, Lyd. Hinder part of left ramus of mandible, from the Siwaliks of Dádúpúr: Indian Museum (No. D. 51).
- „ 4. *HYENA MACROSTOMA*, Lyd. Part of left ramus of mandible, from the Siwaliks of Jabi, Punjab: Indian Museum (No. D. 52).
- „ 5. *HYENA SIVALENSIS*, Bose. Left ramus of mandible, from the Siwaliks; British Museum (No. 16,555).

All the figures natural size, and viewed from the outer side.

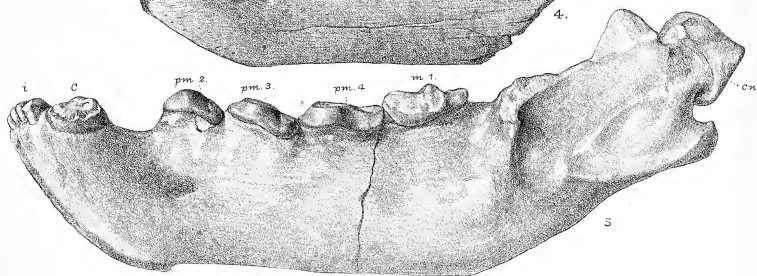
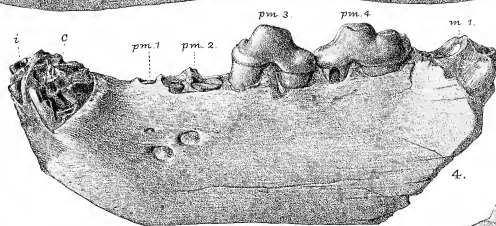
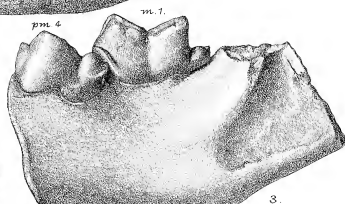
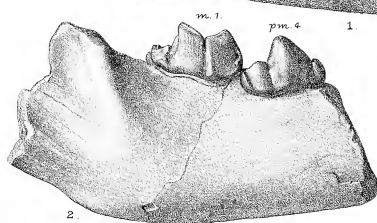
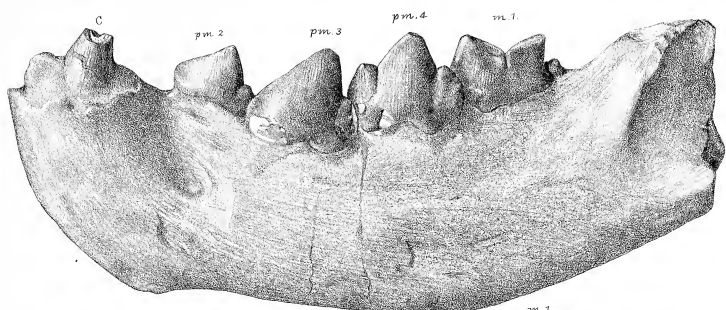


PLATE XXXIX.

CARNIVORA — *Hyænidæ*.

- Fig. 1. *HYÆNA FELINA*, Bose. Dental aspect of specimen represented in plate XXXVIII., fig. 1.
- „ 2, 2a. *HYÆNA FELINA*, Bose. Part of right ramus of mandible, from the Siwaliks: British Museum (No. 16,565): fig. 2 from the dental, 2a from the outer aspect.
- „ 3. (?) *HYÆNA FELINA*, Bose. Part of right ramus of immature mandible, from the Siwaliks Indian Museum (No. D. 50).
- „ 4. *HYÆNA COLVINI*, Lyd. Dental aspect of specimen represented in plate XXXVIII., fig. 3.
- „ 5. *HYÆNA SIVALENSIS*, Bose. Dental aspect of specimen represented in plate XXXVIII., fig. 2.
- „ 6. *HYÆNA MACROSTOMA*, Lyd. Dental aspect of specimen represented in plate XXXVIII., fig. 4.
- „ 7. *HYÆNA SIVALENSIS*, Bose. Dental aspect of specimen represented in plate XXXVIII., fig. 5.

All the figures natural size.

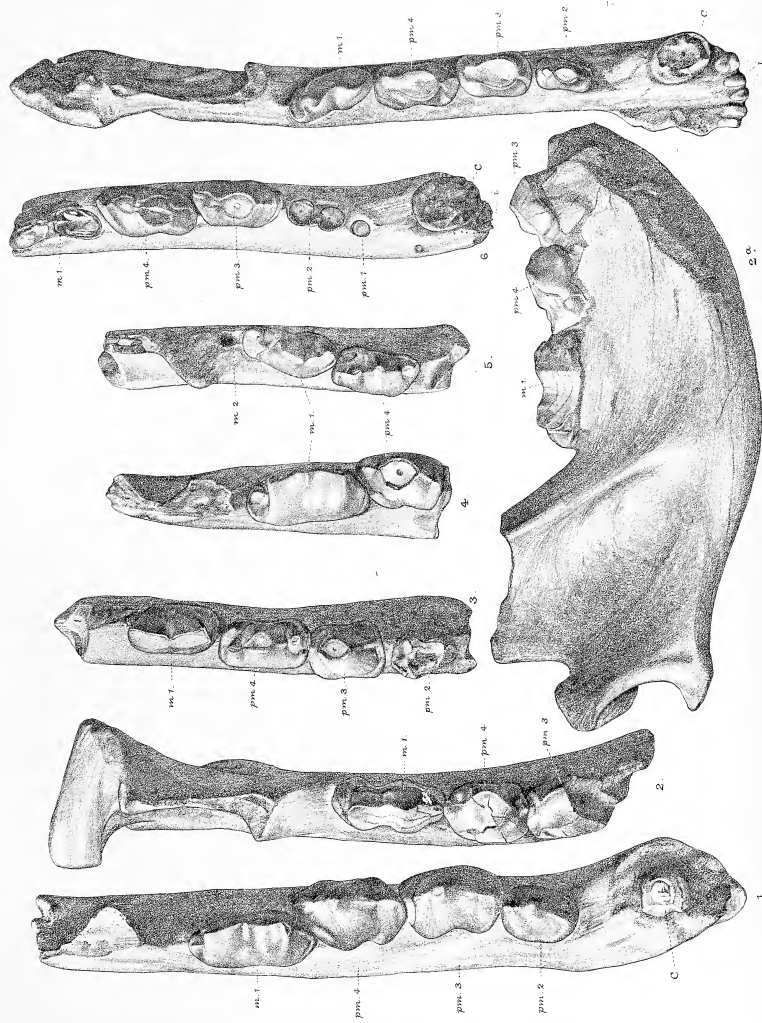


PLATE XL.

CARNIVORA — *Felidae*.

- Fig. 1. *FELIS CRISTATA*, Falc. and Caut. Superior aspect of hinder part of cranium, from the Siwaliks : British Museum (No. 49,176).
- „ 2. *FELIS CRISTATA*, Falc. and Caut. Right lateral aspect of hinder part of very large cranium, from the Siwaliks : British Museum (No. 49,176).

Both figures $\frac{3}{4}$ natural size.

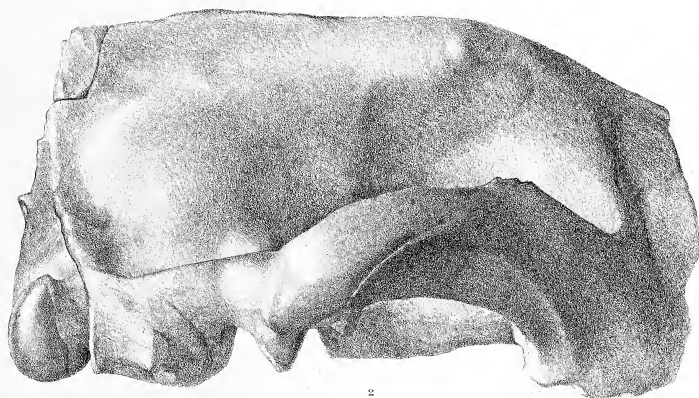
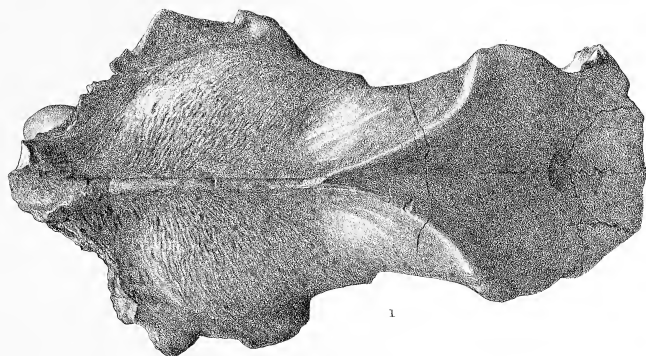
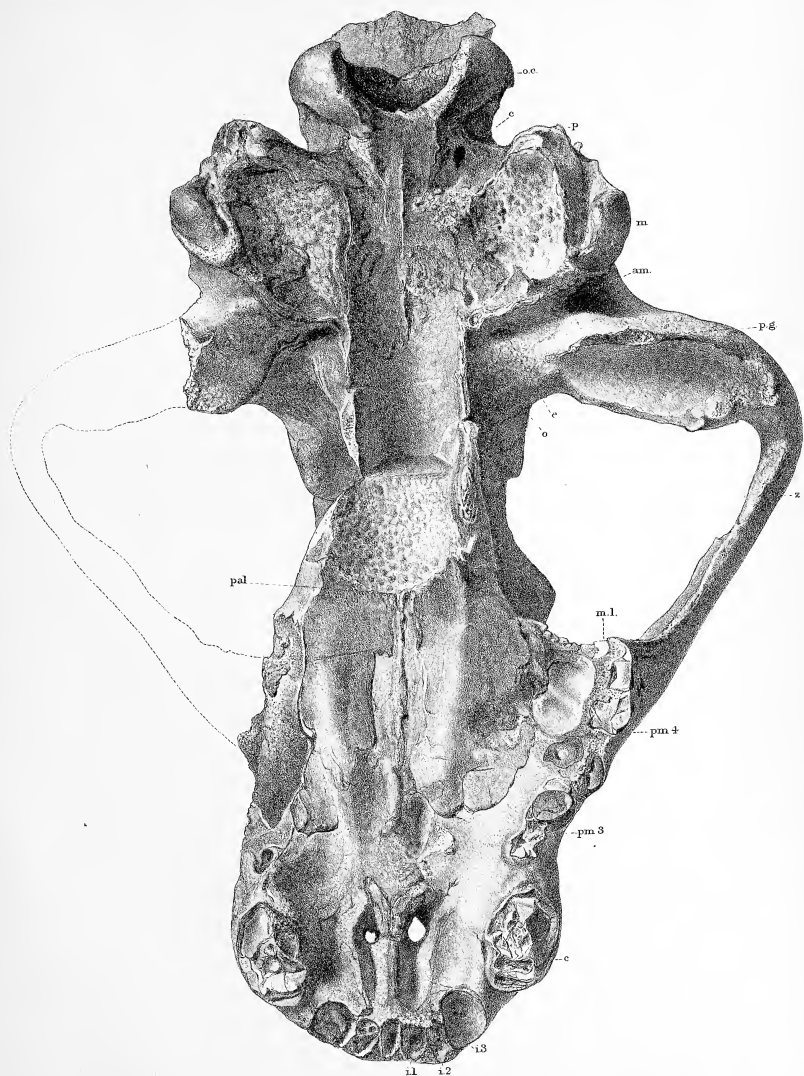


PLATE XLI.

CARNIVORA — *Felidae*.

FELIS CRISTATA, Falc. and Caut. Palatal view of cranium, from the Siwaliks: Museum of Royal College of Surgeons (No. 358). †.

o. c. occipital condyle: *c.* foramen lacerum posticum, with condylar foramen opening into it: *e.* eustachian canal: *o.* foramen ovale: *a. m.* meatus auditorius externus: *p.* paroccipital process: *m.* mastoid process of petriotic: *p. g.* post-glenoid process of squamosal: *z.* zygoma: *pal.* hinder border of palatines.



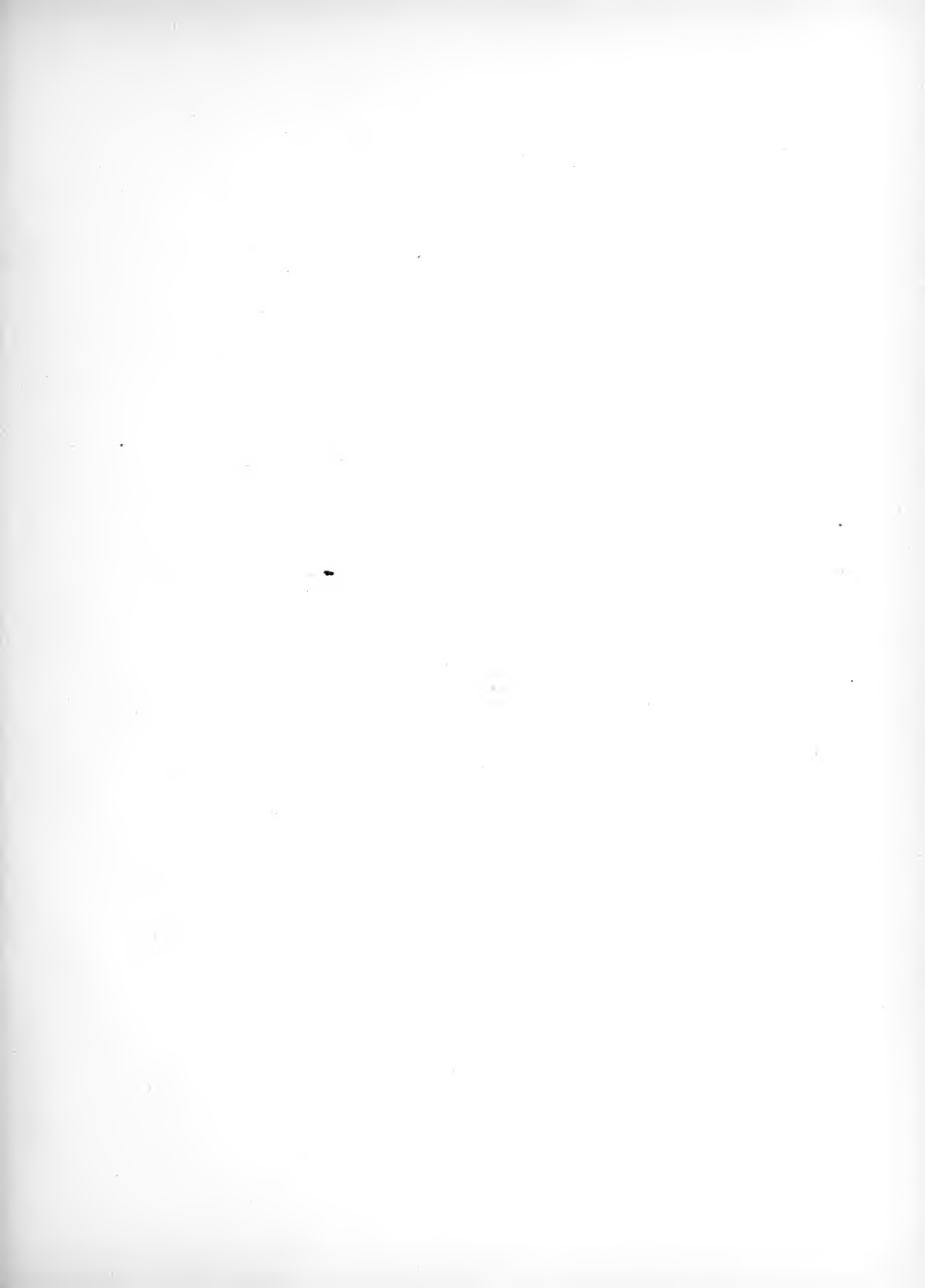


PLATE XLII.

CARNIVORA — *Felidae*.

FELIS CRISTATA, Falc. and Caut. Right lateral aspect of specimen represented in preceding plate: † : letters as before. The dotted line representing the profile of the parietal region should probably have been straight.

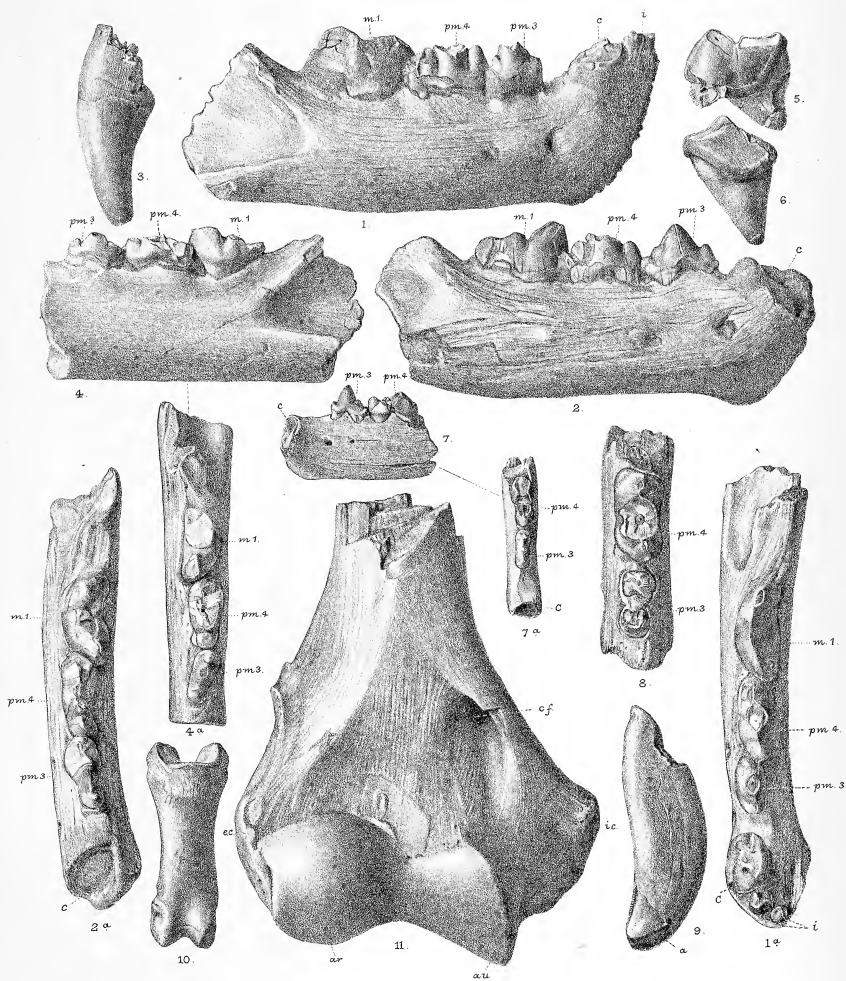


PLATE XLIII.

CARNIVORA — *Felidae* and *Hyenodontidae*.

- Figs. 1, 1a. *FELIS BRACHYGNATHUS*, Lyd. Part of right ramus of mandible, from the Siwaliks : British Museum (No. 16,573) : 1 from the external, 1a from the dental aspect.
- „ 2, 2a. *FELIS BRACHYGNATHUS*, Lyd. Part of right ramus of mandible, from the Siwaliks : British Museum (No. 16,537) : 2 from the external, 2a from the dental aspect.
- „ 3. (?) *FELIS*, *sp. non. det.* Right lower canine, from the Siwaliks of the Punjab : Indian Museum (No. D. 77) : viewed from the outer side.
- „ 4, 4a. *FELIS*, *sp. non. det.* (allied to *F. pardus*). Part of left ramus of mandible, from the Siwaliks : British Museum (No. 16,537, a) : 4 from the external, 4a from the dental aspect.
- „ 5. (?) *HYENODON INDICUS*, Lyd. Third left lower true molar, from the Siwaliks of the Punjab : Indian Museum (No. D. 76) : outer aspect.
- „ 6. (?) *HYENODON INDICUS*, Lyd. Hinder lobe of third right lower true molar, from the Siwaliks of the Punjab : Indian Museum (No. D. 76, a) : outer aspect.
- „ 7, 7a. *FELIS*, *sp. non. det.* (allied to *F. lynx*). Part of left ramus of mandible, from the Siwaliks of Jabi, Punjab : Indian Museum (No. D. 90) : 7 from the external, 7a from the dental aspect.
- „ 8. *MACHÆRODUS PALEINDICUS*, Bosc. Part of right ramus of mandible of a female, from the Siwaliks : British Museum : from the dental aspect.
- „ 9. *MACHÆRODUS PALEINDICUS*, Bosc. Third left upper incisor, from the Siwaliks of Asnot, Punjab : Indian Museum (No. D. 104) : from the inner aspect.
- „ 10. *FELINE*. Proximal phalangeal of a large species, from the Siwaliks of the Punjab : Indian Museum (No. D. 86).
- „ 11. (?) *FELIS CRISTATA*, Falc. and Caut. Anterior aspect of distal extremity of right humerus, from the Siwaliks : British Museum (No. 37,146).

All the figures natural size : fig. 3 is represented as if belonging to the upper jaw.



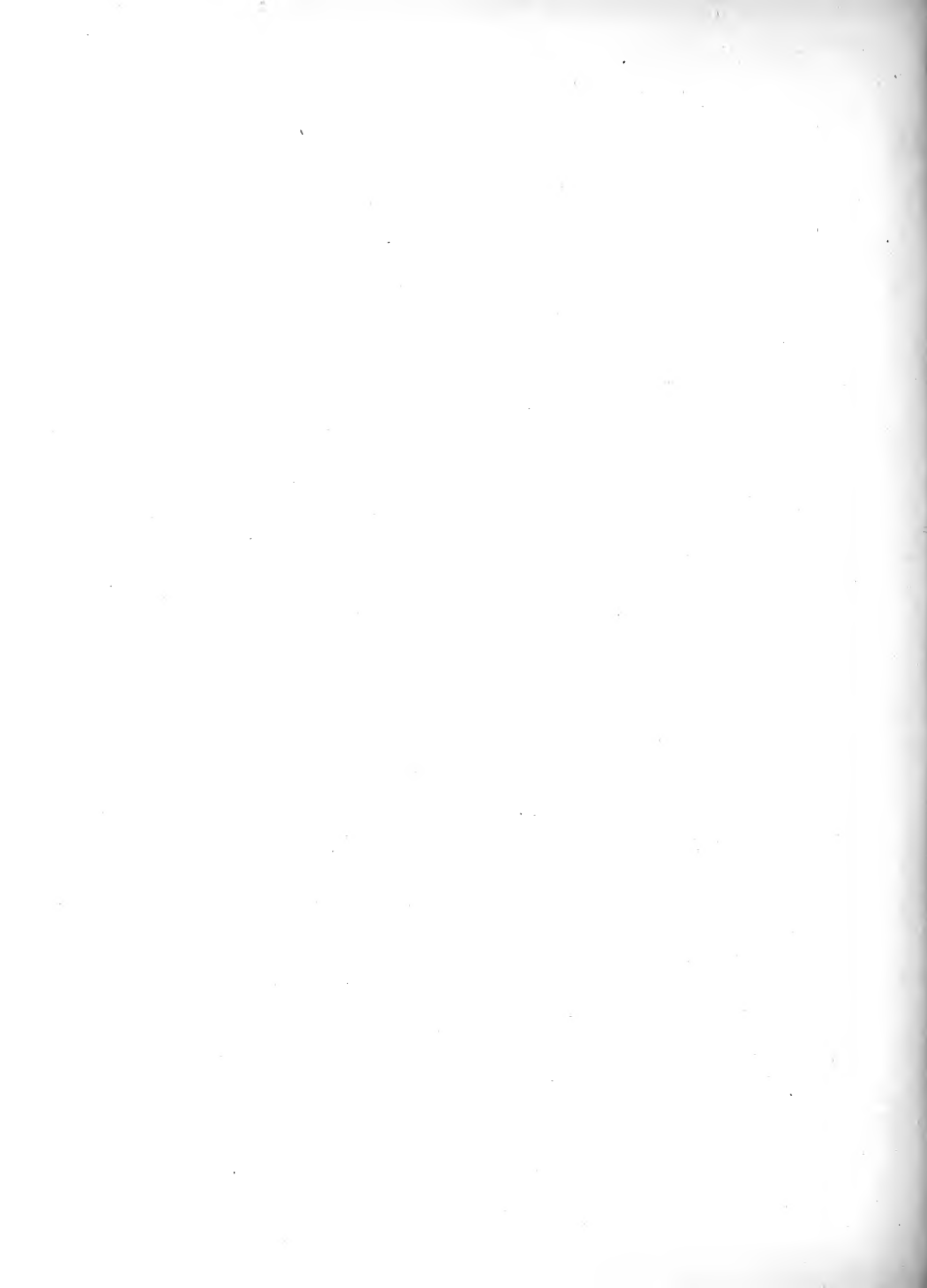


PLATE XLIV.

CARNIVORA — *Felidae*.

- Fig. 1, 1a. *MACHERODUS SIVALENSIS* (Falc. and Caut.). Right maxilla of a cub, with milk dentition, from the Siwaliks : British Museum (No. 16,350).
- „ 2. *MACHERODUS SIVALENSIS* (Falc. and Caut.). Left maxilla, from the Siwaliks : British Museum (No. 39,730).
- „ 3. *MACHERODUS PALÆINDICUS*, Bose. Distal extremity of left ramus of mandible of a male, from the Siwaliks : British Museum (No. 48,436) : from the outer aspect.
- „ 4, 4a. *MACHERODUS SIVALENSIS* (Falc. and Caut.). Part of left ramus of mandible, from the Siwaliks : British Museum (No. 16,537) : fig. 4 from the outer, 4a from the dental aspect.
- „ 5. *MACHERODUS SIVALENSIS* (Falc. and Caut.). Part of right ramus of mandible, from the Siwaliks of the Rûrki district ; Indian Museum (No. D. 100) : from the outer aspect.
- „ 6. *MACHERODUS SIVALENSIS* (Falc. and Caut.). Part of right upper canine, from the Siwaliks of the Punjab : Indian Museum (No. D. 105) : from the postero-external aspect.
- „ 7, 7a. *ÆLUROGALE SIVALENSIS*, Lyd. Right ramus of mandible, from the Siwaliks of the Punjab : Indian Museum (No. D. 95) : 7 from the outer, 7a from the dental aspect.

All the figures natural size.

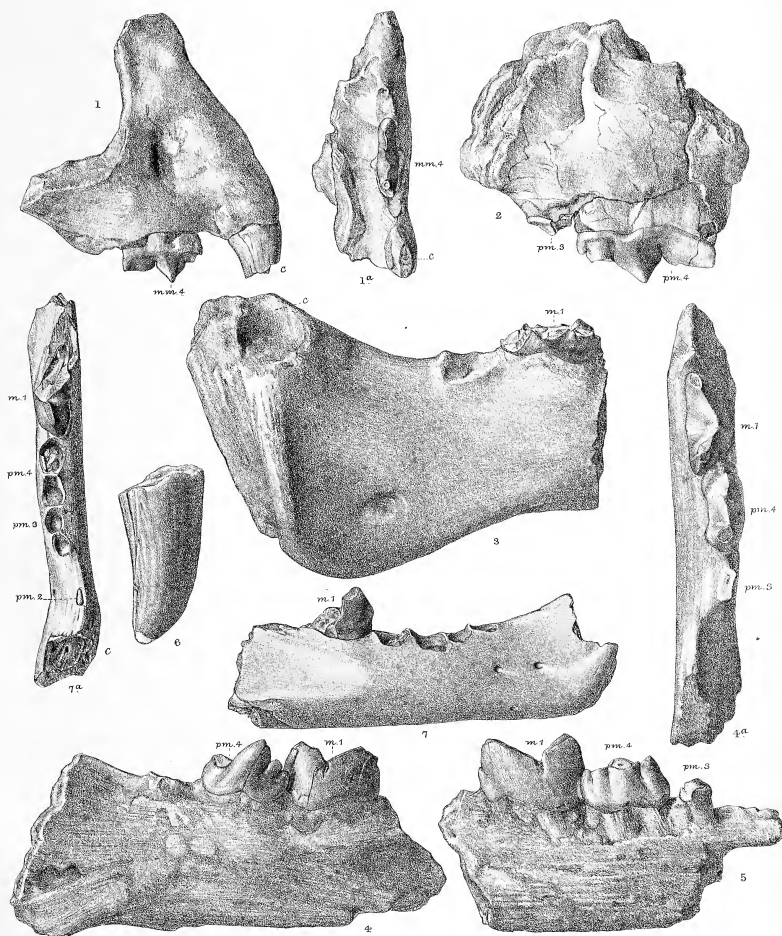
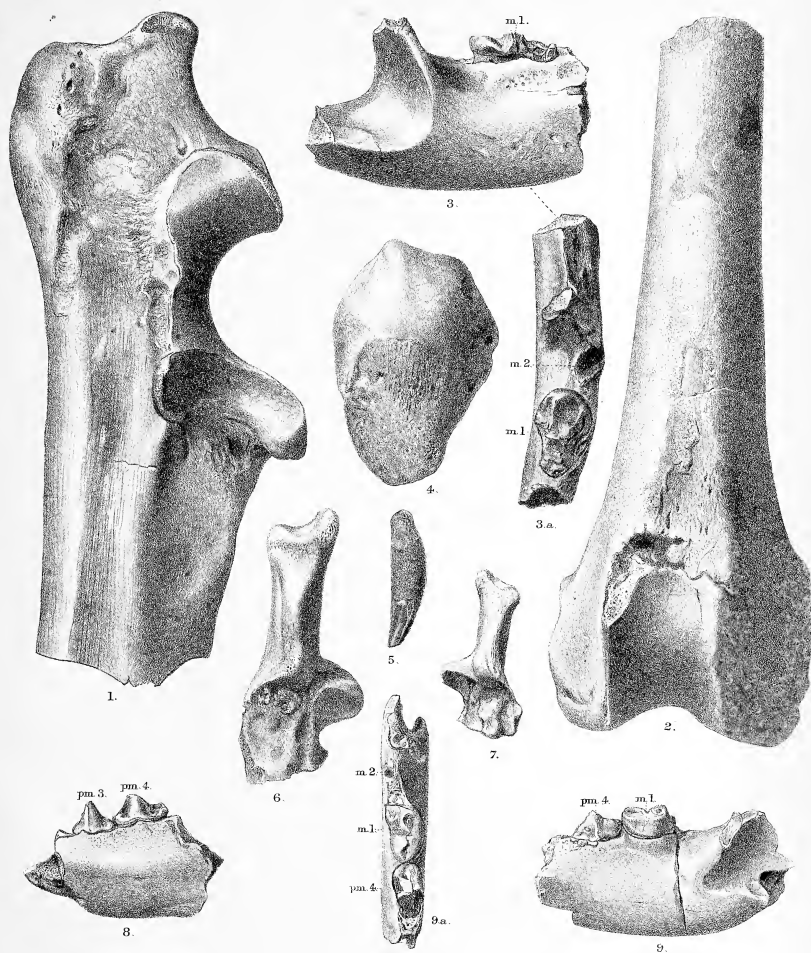


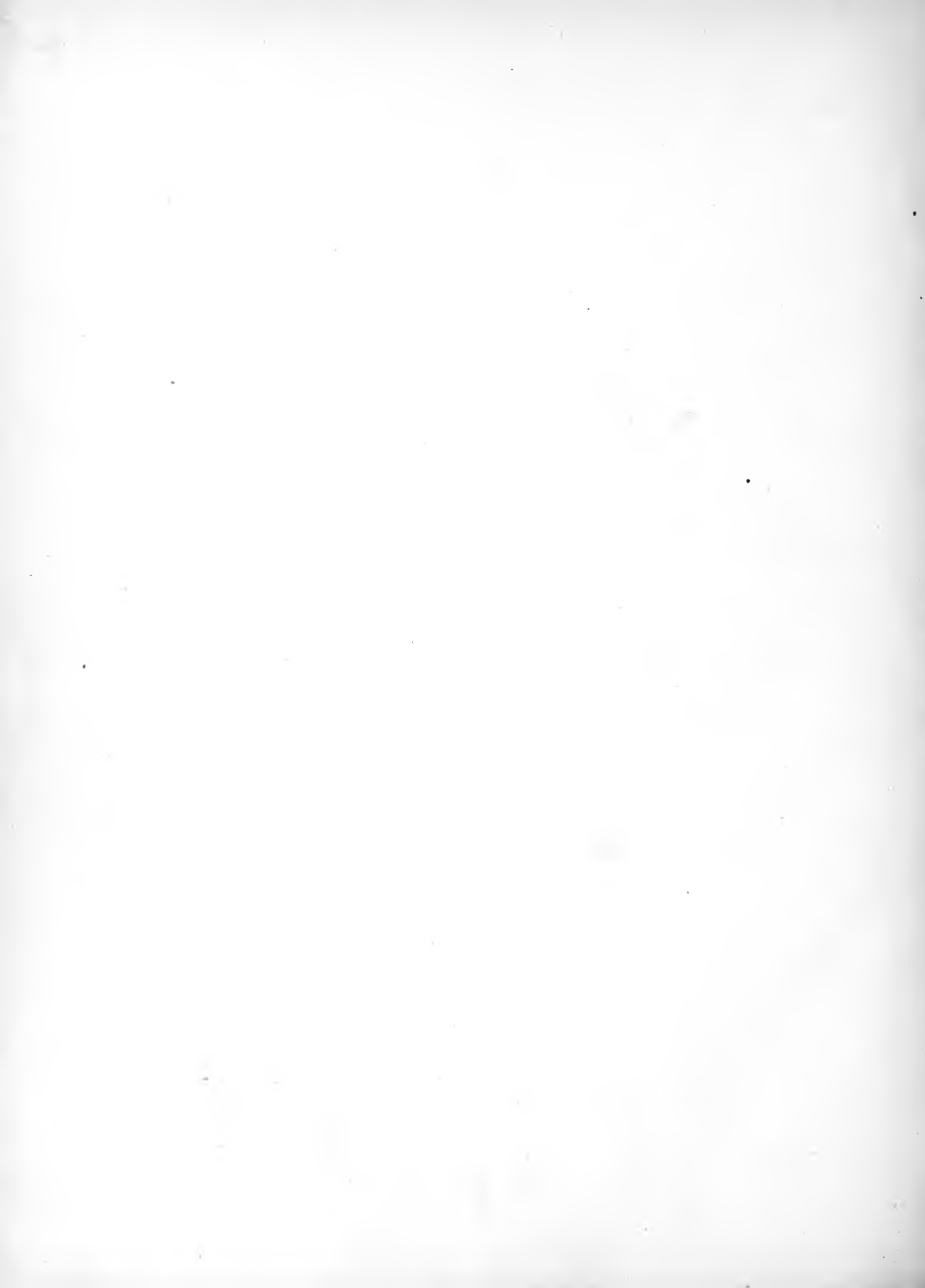
PLATE XLV.

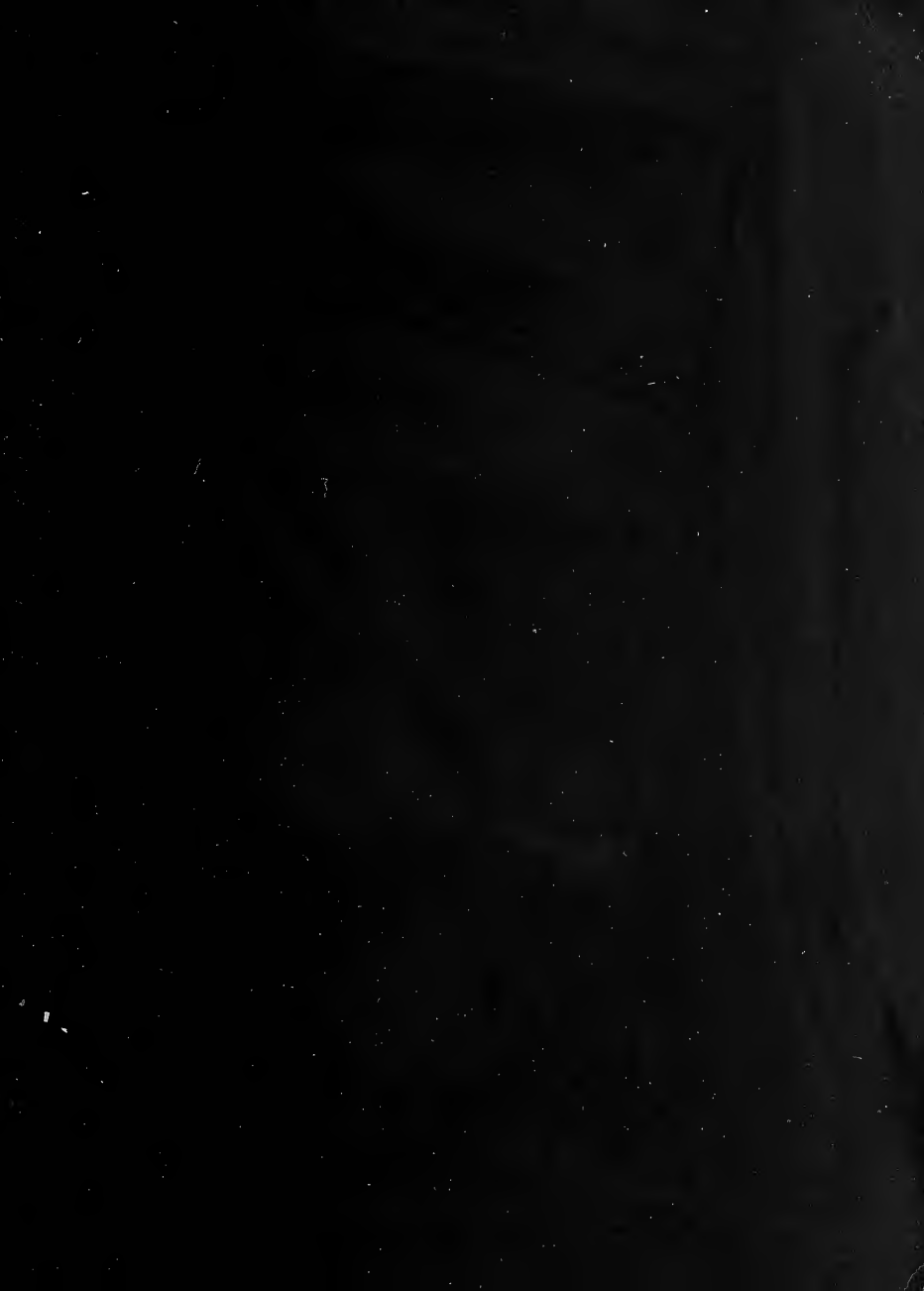
CARNIVORA — *Felidae*, *Hyenidae*, and *Mustelidae*.

- Fig. 1. (?) *FELIS* (*cf. cristata*). Proximal extremity of right ulna, from the Narbadas: Indian Museum (No. D. 74): viewed from the external (preaxial) aspect.
- „ 2. *FELINE*. Distal half of right femur of a large species; possibly *M. sivalensis*; from the Siwaliks of the Punjab: Indian Museum (No. D. 78): from the anterior aspect.
- „ 3, 3a. *LUTRA SIVALENSIS* (Falc. and Caut.). Part of right ramus of mandible, from the Siwaliks: Ipswich Museum: 3 from the outer, 3a from the dental aspect.
- „ 4. *FELINE*. Patella of a very large species, from the Siwaliks of the Punjab: Indian Museum (No. D. 79); from the anterior aspect.
- „ 5. (?) *FELIS*, *sp. non. det.* Left upper canine, from the Siwaliks of Asnot, Punjab; from the inner aspect: Indian Museum (No. D. 40). Equal in size to *F. serval*.
- „ 6. (?) *FELIS*, *sp. non. det.* Right calcaneum of a species equal in size to *F. pardus*, from the Siwaliks of the Punjab: Indian Museum (No. D. 80).
- „ 7. (?) *FELIS*, *sp. non. det.* Left calcaneum of a species about equal in size to *F. lynx*; from the Siwaliks of the Punjab: Indian Museum (No. D. 91).
- „ 8, 9, 9a. *LEPHTHYENA SIVALENSIS*, Lyd. Portions of a mandible, from the Siwaliks of Asnot, Punjab: Indian Museum (No. D. 38): fig. 8 part of right ramus from the inner aspect; figs. 9, 9a part of left ramus from outer and dental aspects.

All the figures natural size.







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